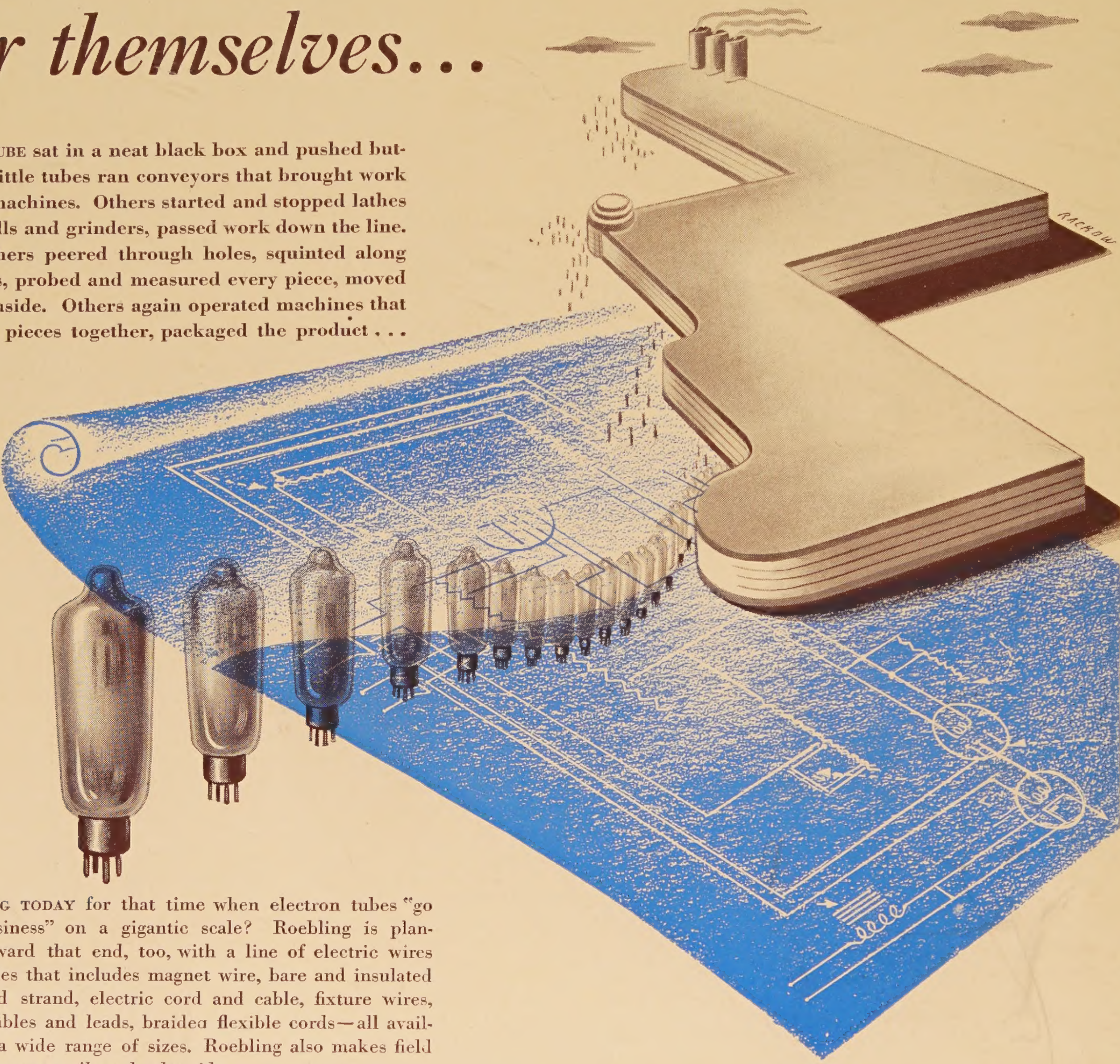
ELECTRICAL ENGINEERING

JANUARY 1943

AIEE NATIONAL TECHNICAL MEETING, NEW YORK, N. Y., JANUARY 25-29, 1943

In 194X . . . a family of electron tubes will go into business *for themselves . . .*

A BIG TUBE sat in a neat black box and pushed buttons. Little tubes ran conveyors that brought work to the machines. Others started and stopped lathes and drills and grinders, passed work down the line. Still others peered through holes, squinted along surfaces, probed and measured every piece, moved misfits aside. Others again operated machines that put the pieces together, packaged the product . . .



PLANNING TODAY for that time when electron tubes "go into business" on a gigantic scale? Roebling is planning toward that end, too, with a line of electric wires and cables that includes magnet wire, bare and insulated wire and strand, electric cord and cable, fixture wires, brush cables and leads, braided flexible cords—all available in a wide range of sizes. Roebling also makes field coils, armature coils and solenoids.

More than this, though, Roebling is equipping and manning today, toward the production of new types of electric wires and cables as these are required by the growing electronics industry and the electrical industry as a whole. For your needs of today and your plans for tomorrow, you can rely on Roebling as your source for everything in electric wires.

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ELECTRICAL ENGINEERING

Registered U. S. Patent Office

JANUARY 1943

The Cover: The auditorium of the Engineering Societies Building, New York, N. Y., showing the improved lighting. For details see pages 18–19 of this issue. Photo by F. S. Lincoln

TRANSACTIONS SECTION

(Follows EE page 50; a preprint of pages 1–52 of the 1943 volume)

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HIGH LIGHTS • •

Long-Distance Transmission. An effective way of increasing the permissible straightaway transmission distance is by means of series-capacitor compensation of part of the transmission-line inductive reactance. Results of a study of hunting and self-excitation during normal operation as affected by line and machine characteristics are given. A 300-mile transmission line, terminated at both ends by a transformer of ten per cent reactance is studied by means of an a-c network analyzer (*Transactions pages 41–4*). A comprehensive analysis of representative circuits with and without series-capacitor compensation has been made to determine the regions of abnormal behavior and the effectiveness of various practical methods for safely limiting overvoltages. Such practical means for controlling the overvoltage include proper switching and relaying arrangements, the synchronous condenser, shunt reactors, and resonant shunts (*Transactions pages 32–40*).

Solving Equivalent Circuits. Since it is impractical to analyze the performance of many electromechanical systems by direct calculation, it is important to develop equivalent circuits for these systems that can be solved by the a-c calculating board. Equivalent circuits are set up with the aid of tensorial hunting equations for the determination of the steady-state, hunting, and self-excitation performance of two interconnected instrument-Selsyns, of two salient-pole synchronous machines, and of a capacitor-compensated transmission line connected to a salient-pole synchronous machine (*Transactions pages 25–32*).

Dielectric-Recovery of Air Gaps. The rates at which large air gaps recover dielectric strength after discharging power-frequency currents and short-duration surge currents comparable with those produced by lightning are of fundamental importance in determining power-system performance. Some of the more important considerations are the factors governing the probability of lightning flashovers producing power follow, the probability of power follow producing an outage, and the minimum safe reclosing time after a circuit interruption (*Transactions pages 45–52*).

Ratings for Intermittent Loads. A suggested method for applying motors to load cycles where the motor stops and the ventilation changes in the no-load part of the cycle is based on certain motor-loss ratios, that is, the relation between the losses dissipated with standard temperature rise running and at standstill and the losses at the nominal or short-time rating. This method is said to permit the application of service-factor or short-time ratings to periodic loads with more exactness (*Transactions pages 4–7*).

National Technical Meeting. The national technical meeting of the AIEE to be held in New York, N. Y., January 25–29, 1943, has a scheduled program of approximately 63 technical papers which are to be presented at 13 technical sessions and 12 conferences (*pages 25–6*). Abstracts of 49 technical papers appear in this issue (*pages 27–34*); others were published in the December 1942 issue.

Adjustable-Speed Motor. One type of polyphase adjustable-speed motor and its control circuit provide an a-c drive that has characteristics comparable to those of the Ward-Leonard d-c system. Low costs of this type of motor and its control system, large speed range, facility for rapid reversal by regeneration, and high starting torque make it suitable for many industrial applications (*Transactions pages 7–10*).

Electronic Instrument. An electronic instrument measures the arcing time of a contact closing or opening a circuit by permitting a current of constant value to flow into a capacitor during the time that an arc exists across the contacts under observation; the charge accumulated on the capacitor is therefore a measure of the arcing time (*Transactions pages 14–16*).

Generator Differential Relay. The product-restraint principle, applied to the generator differential relay, permits a variable-slope characteristic without its usually attendant "blind-spot" error. This relay is said to approach the ideal of fast sensitive protection equivalent to that attainable with perfect current transformers (*Transactions pages 11–13*).

System-Grounding Impedance. Causes of system overvoltage are reviewed by a working group on the correlation of system-grounding impedances, of the AIEE committee on protective devices. The correlation of overvoltages with system-grounding impedance is analyzed by means of miniature-system setups (*Transactions pages 17–24*).

Latin American Power Facilities. An engineer who has had technical experience in Latin American countries presents in this issue some interesting data on power engineering in those countries, discussing generating capacity, frequency, hydroelectric power, thermal plants, transmission, and distribution (*pages 3–9*).

Transpositions. Because the fundamentals on which the design of power-line transpositions is based have not always been clearly understood, an engineer of a large midwestern power company has prepared a brief exposition of the purpose and efficacy of transpositions (*pages 17–18*).

Engineering Auditorium Lighting. Those attending the AIEE national technical meeting in New York this month may see the improved lighting in the auditorium of the Engineering Societies Building where many of the sessions will be held, as usual (*front cover; pages 18–19*).

Plastics in Insulation. An authority on plastics, pointing out the increasing popularity of plastics as electrical insulating materials, discusses sources of organic plastics, various forms in which they are available, and electrical properties of plastics (*pages 19–23*).

Patents. The advantages and disadvantages of the existing patent system in the United States are discussed in this issue, with an eye toward using its best elements as a basis for building the most efficient set of patent laws possible (*pages 10–16*).

Capacitor Motors. A method is presented of calculating low-speed performance of two-speed capacitor motors with open-end type of control winding (*Transactions pages 1–3*).

Coming Soon. Among the special articles and technical papers now in preparation for early publication in *Electrical Engineering* are: a discussion of a common error in the distribution factor of electric machines by R. Andriessen (A '40); an article on the electric pasteurizer by John I. Hall (A '39); a discussion of electromagnetic theory by Ernst Weber (F '34), the first of a series on ultrahigh-frequency waves; a report on civilian protection and industrial and utility operations in England during wartime by Davis M. DeBard; a study of formulas for linear conductors of structural shape by Thomas J. Higgins (A '40); an analysis of steady-state and transient stability of long transmission lines with series capacitors by J. W. Bulter (M '38), J. E. Paul (A '39), and T. W. Schroeder (A '37); a description of an electromechanical calculator designed for the rapid solution of directional-antenna patterns by Carl E. Smith (M '38) and Edward L. Gove (M '35); a discussion of emergency loading of transformers by portable capacitor units by Herman B. Wolf (M '37) and G. G. Mattison (A '41); a description of paired-phase arrangement of bus bars for large polyphase currents by Lawrence E. Fisher (M '38) and Robert L. Frank (A '40); an analysis of equivalent ambient temperatures for loading transformers by W. C. Sealey (M '38); discussion of a method of eliminating switching overvoltage hazard in high-voltage oil circuit breakers by Lloyd F. Hunt (F '38), E. W. Boehne (M '37), and H. A. Peterson (M '41), and a description of wood-pole 230-kv transmission lines by O. S. Clark (M '41).

Photo courtesy of the Brazilian Information Bureau

Power Facilities in Central and South America

R. P. CRIPPEN
FELLOW AIEE

Data on generating capacity, frequency, hydroelectric power, thermal plants, transmission, and distribution in the Latin American countries are brought together in this article by an engineer who has had South American experience. Pointing out the likelihood that certain electric equipment used in Latin America will continue to be bought from the United States, he stresses the necessity of reciprocal trade as a means to harmonious relationships within the Western Hemisphere.

DURING World War I the interest of United States industry in South American trade was awakened when European manufacturers were forced practically to abandon exports to South America. Since that time the exchange of exports and imports between North and South America has greatly increased and many factory branches of United States companies have been established in South America.

The present world war has revived the conditions whereby countries to the south are again entirely dependent upon the United States for certain manufactured articles. In turn the United States urgently needs raw products which these countries, together with Canada, can furnish. There is a large degree of self-sufficiency within the hemisphere. The mutual necessities of hemisphere defense are a powerful influence in making North and South America more considerate of each other's points of view and anxious to learn about each other.

The present general interest in Latin America has led to questions being asked about its electrical industry. The data given here in answer to some of these questions are only what are readily available in various published material but it is believed that they will indicate the general conditions. It seems desirable to outline first some simple general facts which influence both the cultural and technical development of the Latin American countries.

Popular writers have dwelt extensively upon the beauty and romance of the Central and South American countries and upon the temperament of their peoples, sometimes with poetic license and often with only superficial knowledge gained in a quick tour. There are many beautiful spots and there is a very romantic appeal in the swaying palms and the Southern Cross and the tango, if one is young and of adventuresome spirit, but in technical and business matters one should pay principal attention to the analysis of facts and figures.

The state of development of these countries and the reactions of their peoples are mainly determined by cir-

Essential substance of an address given at the AIEE summer convention, June 22–26, 1942, Chicago, Ill.

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Table I. South America; Population by Area and Countries

Country	Population	Area Square Miles	Persons Per Square Mile	Principal City	Population
Argentina	13,318,320	1,078,278	12.4	Buenos Aires	2,470,000
Bolivia	3,426,296	537,792	6.4	La Paz	250,000
Brazil	41,356,605	3,275,510	12.6	Rio de Janeiro	1,800,000
British Guiana	332,898	89,480	3.7	Georgetown	66,000
Chile	5,000,782	296,717	16.9	Santiago	829,836
Colombia	9,334,392	448,794	20.9	Bogota	330,312
Dutch Guiana	150,000	54,300	2.8	Paramaribo	53,000
Ecuador	3,200,000	275,936	11.6	Guayaquil	140,000
Falkland Islands	2,400	4,600	0.5	Stanley	1,200
French Guiana	37,005	34,740	1.1	St. Laurent do Maroni	1,300
Paraguay	1,000,000	174,854	5.7	Asuncion	107,000
Peru	7,000,000	532,300	13.2	Lima	500,000
Uruguay	2,146,545	72,153	29.8	Montevideo	682,664
Venezuela	3,491,159	352,170	9.9	Caracas	300,000

Total area of South America is 6,800,000 square miles, 13.2 per cent of world's land surface.
Total population of South America is 91,300,000 square miles, 4.2 per cent of world's population.

Total area of continental United States is 2,977,128 square miles.
Total population of United States is 131,669,275 (44 persons per square mile).

cumstances and environment. Under these two headings are included a multitude of influences such as climate, natural resources, geography, history, education, good roads, air travel facilities, and the provincial attitude of superiority of many of the "Norte Americanos" who go south. Latin Americans do very much the same things North Americans do under the same circumstances.

FACTORS INFLUENCING LATIN AMERICAN DEVELOPMENT

It should be remembered that the middle class group in Latin America is a much smaller proportionate part of the population than the large middle-class group in the United States. To a greater extent people in Latin America are either rich or poor. This will be noticed when one goes shopping since one will usually find elaborate and beautiful modern stores which cater to the wealthy and other stores with goods for the low-income groups. But modern department stores with good qualities and moderate prices for middle class people are fewer in percentage than in the United States. There are many excellent schools but they are not available to as large a percentage of the population as those in the United States.

In some of the Latin American countries an appreciable percentage of the population is made up of Indians. Where Indians have had adequate opportunities and educational advantages they have often risen to high places among their countrymen.

There are fewer good roads. Such factors as density of population, higher cost of automobiles (which must be imported), and lower percentage of people with sufficient income to purchase an automobile, all have a bearing on the number of good roads.

Climate, geography, and resources are, of course, fundamental in determining the development of a country but must be considered for each country separately.

Spanish is spoken generally throughout all of Central and South America except Brazil, where Portuguese is used. Very few people stop to realize, however, that this means that half the population of South America speaks Portuguese and not Spanish. There is some similarity between the two languages but not enough to allow anything of consequence to be accomplished by trying to use Spanish in Brazil, or by trying to use Portuguese in Spanish speaking countries. Fortunately educated Latin Americans often speak English.

Table I shows the areas of South American countries, their population, the average density of population, and principal cities and their populations. The total area of South America is nearly 7 million square miles, or 13.2 per cent of the world's land surface and it has a total population of 91 million, or 4.2 per cent of the world's population.

Brazil is the largest country of South America, having approximately half of both the population and the area. It is very rich in natural resources. It is slightly larger in area than the United States, excluding Alaska, and has slightly less than one third the population. The average density of population is, therefore, a little less than one third of that in the United States, which is 44 persons per square mile. This low density of population is characteristic of the larger countries in Central and South America, although Cuba and some of the Central American countries, particularly El Salvador, have a greater average density of population than the United States.

Rio de Janeiro is the capital and principal city of Brazil and has a population of nearly two million. It is justly famed for its beautiful harbor. Sao Paulo is the chief industrial city and has a population of 1,320,000.

Buenos Aires, capital of Argentina, is the eleventh largest city in the world and the largest in Latin America, with a population of nearly 2,500,000. It is modern, cosmopolitan, businesslike, and in some ways more attractive than cities of similar size in the United States. It has a subway system. The next largest Argentine

Table II. Central America, Mexico, and Cuba; Population and Area by Countries

Country	Population	Area Square Miles	Persons Per Square Mile	Principal City	Population
British Honduras	58,759	8,598	6.8	Belize	17,000
Costa Rica	616,000	23,000	26.8	San Jose	65,000
Cuba	4,228,000	44,164	96.0	Havana	568,913
Dominican Republic	1,581,248	19,332	82.0	Trujillo	71,297
Guatemala	3,248,000	45,452	72.0	Guatemala City	170,000
Honduras	1,105,504	44,275	25.6	Tegucigalpa	35,000
Mexico	19,478,791	763,944	25.5	Mexico City	1,754,355
Nicaragua	1,380,287	60,000	23.0	Managua	80,000
Panama	467,459	33,667	13.8	Panama City	83,000
El Salvador	1,744,535	13,176	132.2	San Salvador	102,000

Table III. Approximate Electric Generating Capacity in South America

Country	Total Power: Installed Kilowatts	Total Power: Annual Production Kilowatt-Hours	Hydroelectric Power: Developed Horsepower	Hydroelectric Power: Estimated Potential Horsepower	Predominant Frequency Cycles
Argentina	1,136,100 (1937)	2,300,000,000	42,000	5,000,000	50
Bolivia			6,160		50
Brazil	1,186,882 (1940)	30,00,000,000*	1,300,000	20,000,000	50–60
British Guiana					60
Chile	469,132 (1938)	1,500,000,000**		1,400,000 to 4,600,000	50
Colombia	(1938)	212,000,000		4,000,000	60
Dutch Guiana	No current distributed				
Ecuador	16,500 (1938)	51,000,000	10,000	17,000,000	60
French Guiana	No data				
Paraguay	4,375 (1938)	12,000,000	None	Extensive but unstudied	50
Peru	102,176 (1934)	400,000,000 (1938)	80,000 (1934)	4,500,000	60
Uruguay	126,010†	200,000,000 (1936)	34,000 (Rio Negro)		50
Venezuela		400,000,000 (1941) ††			50

Note: These figures are based on reports of the United States Department of Commerce, The South American Handbook (1940), the World Almanac, and other scattered information.

* Estimated. Brazil—85 per cent hydro generation.

** Chile—48 per cent hydro generation.

† Uruguay—1936 figure plus 26,000 kw of hydroelectric capacity under construction on Rio Negro.

†† Estimated.

city is Rosario with a population of slightly over 500,000. Santiago, the largest city in Chile, has a population of over 800,000.

Table II shows corresponding statistics for Central America, Mexico, and Cuba.

As one would logically conclude from these considerations, our neighbors to the south have many cities that are large, beautiful, modern, and sanitary, with the upper class citizens well-educated and highly intelligent. But there are also many smaller and less modern cities and towns where the standard of living of a large part of the population is much lower.

GENERATING CAPACITY

In keeping with these conditions one finds large modern power stations and systems supplying the larger cities and many small isolated plants supplying the smaller towns, which are often too far apart to justify interconnection for the small loads involved.

Tables III and IV show the total installed capacity, annual production, installed and potential hydroelectric capacity, and predominant frequency for the various countries in South and Central America and for Mexico and Cuba.

Buenos Aires is a considerable distance from any hydroelectric source and is supplied from steam-electric stations totaling about 600,000 kw. There are several 50,000-kw modern turbogenerators in these stations.

Rio de Janeiro is near good hydroelectric sites, which are common in Brazil. It is served by 254,000 kw of hydroelectric capacity and a 132-kv transmission system, with a 12,000-kw steam plant as stand-by.

Mexico City is served by a 240,000-kw system which is principally hydro but has some back-up steam.

Santiago, Chile, is served from an interconnected system of steam-electric and hydroelectric units totaling 168,000 kw, which also serves Valparaiso and a number of smaller communities. Another 107,000 kw of hydroelectric capacity is under construction by different agencies in four different plants, which will interconnect with this system.

In the smaller communities stations with a total installed capacity of 25 kw and less are quite common and the smallest central generating station found listed in governmental statistics is 2 kw.

FREQUENCY AND LAMP VOLTAGE

Much of the electrical equipment used in South America has been purchased in Europe and as a result the predominating frequency is 50 cycles and the pre-

Table IV. Approximate Electric Generating Capacity in Central America, Mexico, and Cuba

Country	Total Power: Installed Kilowatts	Total Power: Annual Production Kilowatt-Hours	Hydroelectric Power: Developed Horsepower	Hydroelectric Power: Estimated Potential Horsepower	Predominant Frequency Cycles
British Honduras	428 (1935)	800,000			
Costa Rica	21,265*		21,300	Plentiful	60
Cuba	134,500**	400,000,000	4,500	30,000	60
Dominican Republic	7,500 (1938)	20,000,000	5,600	15,000	60
Guatemala	12,100		16,500	1,300,000	60
Honduras	7,500 (1936)		6,700		60
Mexico	628,980 (1936)		500,000	Plentiful	60
Nicaragua					60
Panama	16,825†	41,000,000			60
Puerto Rico					60
El Salvador	12,000 (1938)	30,000,000	5,6000	200,000	60

Note: These figures are based on reports of the United States Department of Commerce, The South American Handbook (1940), the World Almanac and other scattered information.

* Costa Rica, includes 5,000 kw hydroelectric project under construction.

** Cuba, includes 3,000 kw steam-electric unit under construction.

† Cia Panamena de Fuerza y Luz only. Includes 4,000 kw of steam-electric capacity under construction. Does not include Canal Zone.

dominating lamp voltage is 220 volts. A great number of small isolated plants deliver 220 volts direct current and there are still many 220-volt d-c areas even in the larger cities. Most countries have some 60-cycle systems and also have some systems with nominal secondary voltages between 110 and 125 volts. Ecuador has the least 50-cycle equipment of any South American country with only 250 kw of 50-cycle generating capacity.

There is so much confusion in regard to frequency and secondary voltage that it is usually necessary to determine system characteristics in the particular city, or part of the city, where equipment is to be used before it can be specified.

In Central America, Mexico, Cuba, and the West Indies 60 cycles and 110–125 volt lighting predominate, but here again there are some notable exceptions such as Mexico City supplied by 240,000 kw of 50-cycle generating capacity and Merida, Mexico, with 220-volt 60-cycle lighting.

Tabulation of the frequency and secondary voltage used in each city can often be obtained from the Electrical Division, Bureau of Foreign and Domestic Commerce, Washington, D. C.

HYDROELECTRIC POWER

Referring to Table III it will be seen that there is a large amount of potential hydroelectric power in several countries and that in Brazil and Peru a large percentage of the total generation is by hydro power. About 60 per cent of the generation in Mexico is by hydro power. About half the generation in Chile is by hydro power, some of the plants being located at mines high in the Andes, where there are special problems of insulation of equipment.

Hydroelectric possibilities in the countries of South America, except Brazil, are closely related to the Andes which rise rapidly from the sea on the west coast. A little north of a line drawn between Mendoza, Argentina, and Santiago, Chile, is Aconcagua, rising 23,380 feet, and highest peak in the Western Hemisphere. From the Andes a majority of the rivers of the continent flow westward a relatively short distance to the Pacific or eastward a considerably greater distance to the Atlantic.

At the southern end of the Andes the western slope of the Andes is wooded and has good ground storage conditions which are favorable to hydroelectric developments. The eastern slope, however, is barren so that there is little ground storage and the rivers on the eastern slope are flashy and often bring huge rocks down during flood season. There are hydro sites with many good characteristics near Mendoza, Argentina, but this condition of flashiness of the streams must be taken into account. In northern Argentina there is better ground storage.

The 26,000-kw Maitenes Plant of Compania Chilena de Electricidad, is in many ways typical of hydroelectric developments in Chile, although it was constructed in

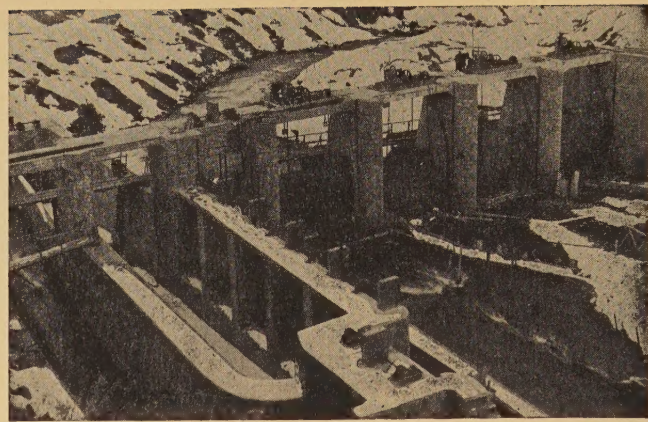

Figure 1. Dam of South American hydroelectric development showing masonry construction

1924. It has a head of 566 feet and has an interesting feature of storing water by off-peak pumping against a 197-foot head.

Water comes to the pumphouse through a canal and then a tunnel. From the pumphouse a canal carries water around a hill to the main penstocks. Also from the pumphouse other smaller penstocks extend up the hill at an angle of about 45 degrees to a storage basin. From the top of the main penstocks a small canal extends on around the hill and brings in additional water from a small drainage area in the canyon on the other side of the hill.

At off-peak periods the two 2,000-kw synchronous machines at the pumphouse are used to drive pumps on one end of their shafts, which pump excess water to the storage basin. During peak-load periods the stored water is drained back down the hill and drives hydraulic turbines on the opposite ends of the shafts from the pumps. The synchronous machines act as generators to reclaim 4,000 kw of power before the water is carried on down the hill to the main generators.

Masonry construction of both powerhouses and dams is often used in South America. The workmen there are expert in this type of construction. Figure 1 shows construction work now in progress on a dam in Chile. Water is to be brought through a hill and after developing 14,000 kw at the plant will be discharged into the forebay of another plant to give this plant more water and an additional 4,000 kw of prime capacity on the present machines.

Along the southern coast of Brazil is a narrow coastal plain often only 10 to 15 miles wide which extends for several hundred miles. At the inner edge of this narrow strip is an abrupt rise of about 2,500 feet, known as the Serra do Mar, at the top of which is the plateau that constitutes the southern part of Brazil. The elevation of this plateau gives it a moderate climate and many of the mineral and agricultural resources of the country are in the area. Sao Paulo is on this plateau and the main industrial development of the country centers around it.

Most of the large amount of potential hydroelectric power of Brazil is in the rivers originating on this plateau.

From the top of the Serra the land falls away gradually to the west. Prevailing southeast winds bring moisture-laden atmosphere in from the South Atlantic. As it rises over the Serra it is cooled a few degrees, resulting in an area of very heavy rainfall just over the edge of the Serra on the plateau. Here rainfall averages 16 feet a year in certain places and sometimes reaches $22^1/_2$ feet, decreasing further inland to 4 or 5 feet annually.

Many of the rivers originating on this plateau flow westward and unite to form the mighty Parana River which flows southward. At the Argentine–Brazilian border the Parana River is joined by the Iguassu River just after it has passed over the famous Iguassu Falls, which are between Brazil and Argentina. These falls are 200 feet high and the front of the falls is a mile and a half long. They rival Niagara and constitute a potential 250,000-kw development.

About 250 miles downstream from the confluence of the Iguassu River with the Parana are the Rapids of Apipe, between Argentine and Paraguay, with a potentiality of 500,000 kw. After being joined by the Paraguay River and smaller rivers, many of which have originated in the Andes, the Parana and Uruguay Rivers unite just above Buenos Aires to form the Rio de la Plata, which is 29 miles wide as it passes Buenos Aires and which empties into the Atlantic Ocean at Montevideo. Waters which fell as rain a few miles from the Atlantic at the top of the Serra do Mar have traveled nearly 2,000 miles and dropped 2,500 feet to get back to the Atlantic again.

The Serra Development of the Sao Paulo Tramway, Light and Power Company is near Sao Paulo. It is famous because of its potentiality of 1,500,000 kw and also because of the novel method of storing water at the top of the Serra do Mar by a series of interconnected reservoirs. So far the main storage reservoir and one auxiliary storage reservoir have been constructed, as well as a small forebay reservoir for the penstocks down the Serra. Water in the auxiliary storage reservoir is discharged into a river bed which has been cleared out to form a canal. From this canal it is pumped through a head of from 25 to 85 feet into the main reservoir.

The canal also extends on past the auxiliary storage reservoir to a point on the Tiete River. A pumping station is installed at this point so that water from the Tiete River can be pumped through a head of about 15 feet into the canal and then from the other end of the canal into the main reservoir as described.

Water that is pumped through heads of from 25 to 100 feet in the system of reservoirs and waterways mentioned flows down the Serra under a head of about 2,300 feet to the powerhouse on the coastal plain below. At present there are five horizontal units installed with double overhung impulse-type runners. They are capable of carrying a total of 267,000 kw.

Table V. Countries in South and Central America Having Fuel Resources

Coal	Oil
Argentina*	Argentina
Brazil	Bolivia
Chile	Brazil*
Mexico	Colombia
Panama*	Cuba
Peru	Ecuador
Venezuela	Mexico
	Peru
	Venezuela

* Only in small or as yet undeveloped amounts.

THERMAL PLANTS

Table V shows the countries with coal and oil as natural resources. Coal is scarce. Even those countries having coal deposits have not been able to develop them sufficiently to meet all their own needs. As is well known several of the countries have excellent oil resources.

Steam-electric practice does not vary much from that in the United States. The largest units are 50,000 kw and are installed in Buenos Aires, Argentina.

A number of steam turbines built on the Ljungstrom principle are in successful operation but most of these are in sizes of 5,000 kw and less. In these turbines the steam enters at the middle of two rotors which rotate in opposite directions. The steam then flows radially outward through rows of blades that are placed alternately on one rotor and then the other in circular rows. Each rotor drives a separate generator and the two rotors are kept rotating at equal speeds in opposite directions by having the two generators permanently synchronized together electrically.

Diesel engines are used extensively in the smaller stations. In Villa Maria, Argentina, there are two 4,500-horsepower Diesel-electric sets which are believed to be the largest in South America. However, there are not many Diesel-engine sets of more than 1,250 kw installed. Conditions which determine whether a Diesel-electric or a steam-electric set is to be installed vary with kind of fuel most readily available, cost of fuel oil, cooling water conditions, and many other factors. Most of the thermal units of 1,250 kw and above are steam driven. High maintenance costs per kilowatt-hour, as compared to similar sized steam turbines, handicap the larger Diesel sets.

In a few instances where coal and oil are difficult to transport, wood-burning boilers are still in regular operation. Coffee hulls and bagasse are burned regularly in some plants when available and are supplemented by oil or other fuels when the coffee season or sugar cane grinding season has passed.

During the present disturbed world-shipping conditions, several of the countries are having difficulty in obtaining sufficient coal and oil for their needs. In Argentina there is a surplus of corn and bran and these are being burned as fuel.

There are a few remaining engine sets using producer gas made from wood, but these are usually old plants in small towns and are used only for stand-by.

TRANSMISSION

Transmission lines are less common and usually of lower voltages in Central and South America than in the United States. This is because the use of electricity is less per capita, and the towns are often too small and distances between too great to justify interconnections between the present small isolated plants.

The highest voltage lines in South America are the 132-kv lines which bring hydroelectric power to Rio de Janeiro. There are two extensive transmission systems in the state of Sao Paulo, Brazil. An 88-kv transmission system distributes power from the Serra Development of Sao Paulo Tramway, Light and Power Company and a 66-kv transmission system operated by companies associated with the American and Foreign Power Company supplies power to the northern part of the state of Sao Paulo by interconnecting a number of small hydroelectric plants. These two systems can be operated in parallel over the 88-kv lines of the Paulista Railway.

Chile has a 110-kv system supplying hydroelectric and steam-electric power to Santiago and Valparaiso and intervening territory. Argentina has one 66-kv line and some 44-kv and 33-kv lines which will eventually be extended to form parts of more extended interconnections. Venezuela has a 33-kv transmission system bringing hydroelectric power to Caracas. Mexico has several 110-kv and 66-kv transmission systems.

In Cuba there is 416 miles of 33-kv line extending from Havana to Nuevitas and normally operated closed through all the way. This does not include radial branches, but is the shortest transmission distance between the two end points. Most of it is single circuit, only 30 miles being double circuit. At the Havana end there is 90,000 kw of steam-electric capacity and there are a number of steam and Diesel generating stations of up to 5,000-kw capacity and one small hydro station connected to it at various points. Loads are tapped to it wherever they occur. A 4,000-kva synchronous condenser is at present being installed 94 miles from Havana.

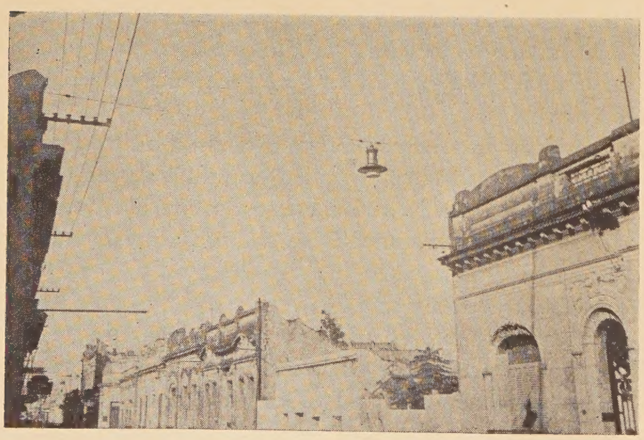

Figure 2. "Mensula" construction of distribution lines

Good native poles are scarce in most parts of Central and South America and steel towers are common for transmission construction. However, in some places, such as Cuba and Southern Brazil, hardwood poles are available locally which have good natural resistance to decay or insect attack except for an outer layer of sap wood. Good results are being obtained with such poles without treatment. They are apparently similar to greenheart and wallaba in strength and resistance to decay and insect attack. Some of these latter poles were imported into the United States before the war from British Guiana and are now being tried out on transmission and distribution work.

DISTRIBUTION

A considerable number of systems in South America use 220/380 wye four-wire secondary systems. When the primary distribution system is also four wire, and common neutral construction is used, the resultant distribution system can be quite economical. Where 220-volt lighting is used the secondaries can be extended much farther from the step-down transformers than 115-volt secondary systems in the United States.

Since in many areas good native poles cannot be obtained many of the urban overhead distribution lines are on steel poles. Reinforced-concrete poles are used quite extensively for distribution lines in Brazil and Chile, with varying degrees of success, and they are being tried out in Argentina.

On narrow streets it is quite common to use "mensula" construction, which means brackets attached to the fronts of the buildings or houses. In Latin American countries the houses are usually of masonry construction and built right up to the front property line, which makes the use of brackets practicable. This is illustrated by Figure 2.

On underground systems there is very little use of ducts for the cables. Direct burial is the usual practice. In laying cable, a trench is dug about two and one-half feet deep. Sand is usually poured along the bottom of this trench and the cable laid in this sand. The cable is covered with sand and some sort of protective covering such as boards, bricks, or tile is placed on top of this sand. The fill is then completed and the sidewalk or paving completed over it.

In some places directly buried nonmetallic-sheath cable has proved quite successful, but in other localities and under different conditions difficulties have been experienced with it.

In some instances "kiosks" are used to house distribution transformers. A kiosk is merely a small housing for a transformer which is placed near the curb line and above the surface of the sidewalk. It is like a small vault which is above the sidewalk instead of below it.

RESIDENTIAL, COMMERCIAL, AND INDUSTRIAL LOADS

Table VI shows the average residential consumption for the companies of the American and Foreign Power Company group in various countries in 1939. In general, these averages are low compared with the figure of 1,000 kilowatt-hours being approached as the average for the United States as a whole. This means, of course, that there are more minimum-use customers in these countries than in the United States.

In most of the Latin American countries the supply of servants is adequate and cheap, but they often lack even rudimentary education and are not readily adaptable to new methods of doing things. Cooks often prefer wood- or charcoal-burning stoves or ovens. Electrical appliances often deteriorate rapidly or are actually destroyed by incompetent handling.

Nevertheless electric pressing irons are quite popular. Also washing machines are gaining acceptance in new places because laundresses wear out clothes rather rapidly through old-fashioned scrubbing methods. In a few places such as Guatemala and Colombia electric cooking has gained considerable favor and the average use is high.

For the last ten or fifteen years there has been a steady and substantial rate of growth shown by commercial and small industrial loads in many of the Central and South American countries. This is due to a steadily increasing tendency toward local manufacture of many small articles that are used on a large scale by the local population. The enterprises are small enough so that they can be financed by local capital without too much difficulty. The falling rate of exchange of many of the currencies during the last few years and resultant foreign exchange difficulties have encouraged this tendency.

ELECTRICAL MANUFACTURING PLANTS

Argentina and Brazil have more facilities for the manufacture of electrical equipment and materials than any of the other countries. Each has a cable manufacturing plant where rod copper is drawn down and fabricated into many types of conductors up to 15-kv paper-insulated lead-covered cable. Each has an assembly plant for watt-hour meters. Transformers and insulators are made in Brazil.

It probably can be anticipated that local manufacture will increase in those things which find widespread use in each country. But for a long time to come many of those things which are large, or special, or of which not many are needed, will continue to be purchased from the United States or Europe. There will not be enough demand for large articles requiring highly specialized manufacturing equipment to allow equipment to be obtained and an organization to be set up locally to make them economically.

But if we in the United States are to sell Latin America such equipment we must bear in mind that our trade has to be reciprocal. Latin America cannot buy from the United States if the United States does not buy from Latin America, whether it is Argentine beef and grains, Chilean nitrates and copper, Bolivian tin, or Brazilian coffee.

OPPORTUNITIES FOR ENGINEERING GRADUATES

Questions are often asked about the opportunities for engineering graduates in Central or South America. There is little present need for inexperienced technical graduates of United States citizenship in these countries. Legal restrictions in the form of labor laws or requirements for engineering licenses practically prohibit engineers of United States citizenship from being employed for engineering work in several countries, unless they were already resident in the country when the laws were passed. The countries having such laws usually have universities with good engineering courses and good technically trained men are available from these schools. Occasionally there is need for an engineer with specialized training in some particular type of work.

Table VI. Average Kilowatt-Hour Sales Per Residential Customer in 1939

Ebasco Client Companies in Central and South America

	Kilowatt-Hours Per Year
Argentina	236
Brazil	295
Chile	489
Colombia	479
Cuba	272
Ecuador	318
Guatemala	516
Mexico	275
Panama	397
Venezuela	433
Average	371

Note: Costa Rica not included because most of residential customers are still on flat rate.

There is little occasion to employ inexperienced engineers of United States citizenship in electric-utility work in Latin America, even in those countries where their entry is less difficult. It is sometimes desirable however, to employ engineers of United States citizenship for special or supervisory work.

In spite of the lack of opportunity for employment of inexperienced engineers in these countries it seems desirable to encourage the teaching of Spanish and Portuguese in United States schools because they are live languages for which engineering graduates in the United States may find practical use.

It seems evident that after the war the relations of the United States with its neighbors to the south are going to be closer than ever before. The mutual solution of present problems will lead to increased mutual respect and understanding, which will not be lost when war conditions have passed.

Inventions, Patents, and the Engineer

WILLIAM E. CRAWFORD
FELLOW AIEE

Benefits derived by the engineer and by the public from the United States patent laws are surveyed here by an engineer. He discusses the opposition and the apathy of certain groups toward the American patent system and points out the importance of stimulating the interest of engineers in the attacks upon it. Although he recognizes shortcomings in the system, he urges that those of its elements "that have made the United States outstanding as an inventive nation" be retained as a foundation for a program of improvement.

SOMEONE has said, "Marconi, too, had to meet that infallible test of greatness—the threat of some fool to shoot him for having brought to the world a great blessing. We always try to crucify our benefactors."

Some of you are in a real sense the "benefactors." But we must keep in mind that we are all benefited by the many inventions and improvements being made. Let us not crucify those who would bring the blessings to us.

Many of you are employed to search for new things. Your own bread and butter comes from the fact you are able to produce something no one else has yet produced. For whom? Not for yourself alone, but for all, since knowledge once created and published to the world is of common benefit. But who pays you? Whether you work for a corporation or yourself, almost surely, your actual pay always has to come from some industrial unit. Such a unit constitutes a family composed of stockholders or investors, managers, and workers producing something for the public.

Others of you engineers deal mainly with engineering principles, such as the economical utilization of forces and materials. These are applied to problems of construction. The construction or reconstruction comes, however, mainly because of obsolescence of the old by the appearance of the new. You are also actively employed because of the progress of creative activity.

We should then be interested in invention. But inventions are generally associated with patents, and patents are the subject of much public controversy today. When it comes to patents it probably is true that "fools rush in where angels fear to tread." However, we can't afford to be angels that are frustrated by our fears, nor fools that try to write finis on all the arguments which may exist.

It is important at the outset to agree on the meaning of the term invention. The statutes do not define it and the dictionary meanings are abstract. To me invention simply means something new and useful. It is in this sense that I propose to employ the term. I am aware that in this definition there is a twilight zone, because invention depends on facts. Nevertheless, we need not exhaust our energies in trying to determine the limit of that zone.

When we speak of invention, we think of patents. The terms are not synonymous, but the general public thinks of them in that sense. The Constitution gives the Congress the power to take steps to promote the progress of the arts and sciences. This power is discretionary and early in the history of the United States the patent laws were enacted by Congress to promote and protect inventions. Some people approach the question as a Constitutional one, and feel that the Constitution has guaranteed the "exclusive right for limited periods." To them patents are property and cannot be taken away without due process of law. I think it should be pointed out that the patent laws may be repealed or changed by Congress, or another system enacted.

INVENTIONS AND THE PUBLIC

The engineer enjoys a professional status that involves a responsibility to the community. He has no right to look at inventions from a purely selfish viewpoint. Let us then first inquire how inventions benefit the nation, and next, their immediate effect upon the engineer.

The difficulty of creating new inventions is enhanced by the public's timidity and scepticism toward new inventions. This is true even though the invention is a prime benefit to the public. There is today, and there has been since early times, not only disbelief in the possibility of creating new things, but also the studied opposition to the introduction or use of them after creation. An illustration of disbelief in new things is the classic example of a remark attributed to a former railroad magnate when he dismissed Westinghouse and his new air brake with the statement that he had no time to waste on fools, and that an iron engine cannot be stopped by wind.

Other members of the public have opposed inventions on a different score. The cry is raised that the standard of invention has deteriorated and that all the basic in-

Essential substance of a talk given before a joint meeting of the engineering and technical societies of Milwaukee, Wis., sponsored by the Engineer's Society of Milwaukee, on October 1, 1942, at Marquette University.

William E. Crawford is a consulting engineer with the A. O. Smith Corporation, Milwaukee, Wis.

ventions have been made. Let us look at one of these inventions. Edison made the first successful incandescent light. Edison did not originate the idea of employing the electric-resistance heat of a filament to create light. Yet we are all agreed that this invention is basic. He merely took that filament, which was already known, and made it thinner so that it had a higher temperature and was more incandescent. An engineer of Edison's day or of today would say any freshman should have known what that would do.

In answer to the cry that all basic inventions have been made, I believe we make a mistake in trying to classify inventions into basic and secondary before their history has been made. Edison's light is a good example of a basic invention, which to us appears so obvious that had it not revolutionized the lighting art, we would not today consider it as basic.

From another quarter of the public comes the argument that the multiplication of inventions results in lesser jobs. The answer to this can be found in figures of the National Industrial Conference Board based on the 15th census of the United States quoted from "Men and Machines," a publication of the National Association of Manufacturers. This publication shows that between 1870 and 1937, while the population in the United States increased 218 per cent, those engaged in gainful occupations increased 290 per cent. After the Civil War it required 324 workers per 1,000 of population to produce the goods and services needed, whereas in 1930 it required 398 such workers, because more goods and services were being used.

The national wealth of the United States cannot be increased by obstructing growth, or by ploughing under crops, or by the theory of scarcity. Inventions have promoted commercial progress. The progress of chemistry has given us wallboard from sugar cane, plastics from soya beans, and many new products from corn and cotton, of which the potential benefit to the world is not questioned. This has created new industry and new jobs. It cannot be contended seriously that inventions have not been beneficial to the public.

For example, look at the automobile's pneumatic tire. If improvements are not important and considered as a benefit to the public, we would be back where I paid $35 wholesale for a new casing that wore paper thin in 5,000 miles. It has been estimated that chemical inventions relating to improvement in the manufacture of automobile tires during the years 1928 to 1940 have saved the people of the United States $500,000,000.

It seems clear, therefore, that inventions in the past have been distinctly beneficial to the public and that a little thought and analysis can readily meet the arguments advanced against the promotion of further invention.

INVENTIONS AND THE ENGINEER

How do inventions benefit engineers? The benefit of inventions to engineers is inevitably tied up with the benefit of inventions to the general public. For example, the A. O. Smith Corporation of Milwaukee, Wis., developed some new ideas that brought welded line pipe to the market. This pipe was thinner and larger in diameter than the seamless line pipe then known. The sales of a competitor, a large company producing seamless line pipe on age-old lines, immediately decreased. It set to work to recoup, and as a result, developed seamless pipe of a large diameter and thin wall to meet the competition of the Smith Corporation. Welded pipe and large-diameter seamless pipe were given to the public through these endeavors that arose out of healthy competition.

The public benefited by a better and cheaper pipe that greatly enhanced the profitable use and transportation of gas and oil. The engineers benefited by both companies' improvement because more engineers had to be employed to work on the engineering problems involved in meeting the competition. The engineers employed by these companies also gained in income and in standing, because the business of both companies was increased, which created new opportunities for investment in plants and in other products requiring engineering services.

The traditionally natural or human action is to cling to the old and resist the new. The engineer is not immune from such instinct. During our engineering training we are taught principles and, so far as possible, facts. We are concerned with the known already complete. There is often such a lack of contact with creative imagination in school and in work, that there is danger of developing reactionary conservatism toward inventions.

I once met in Monterey, Mexico, a man from the States named Wilson. He was a practical inventor who condemned our whole school system on the ground that our methods of assertion of authority tended to destroy all native imagination possessed by youth. He went so far as to say that a youth should be rescued from such a system by some aid to individualism and personal effort if he is to have a reasonable chance to remain inquisitive.

C. F. Kettering, vice-president in charge of research, General Motors Corporation, Dayton, Ohio, has said that when the General Motors company takes on college men for its research department, it is preferred that they come during the vacation of their junior year, so they both have a chance to appraise each other before the period of school is finished. He said if they survive the two great shocks they always receive, he can hope that they will be O.K. First, it is always a great shock to find out what apparently simple things the great General Motors laboratories are working on, such as, "What is Friction?" The second great shock is that they can find practically nothing about it in the library. It is natural, therefore, that we as engineers should carry over into our work from our school days a lack of inquisitiveness.

A certain man has written a book on "Rules for Suc-

cess." One of his rules, number 816, states, "When confronted with a new idea, you are more certain of being right if you vote against it."

Reasons:

1. It may not be a good idea; it seldom is.

2. Even if it is a good idea, the chances are that it will never be put to a test.

3. Even if it is a good idea, and is tried out, the chances are it won't work the first time.

4. Even if it is a good idea, is tried, and is successful, there will be plenty of time to think up alibis.

Therefore:

"When confronted with a new idea, you are far more certain of being right (or at least safe) if you take a very definite and positive stand against it."

Too many of us, I am afraid, live by this rule. Now most of us know that research is the industrial unit's method of bringing forth new improvements, new inventions. As Justice Felix Frankfurter of the United States Supreme Court puts it, "Research is the systematic indulgence of curiosity." This most of us know. However, the great majority of engineers are not employed on research, but on ordinary engineering problems.

What these engineers do not stop to think about is that it is this very research that creates new engineering problems to work on. New construction and the obsolescence of devices and methods magnify these problems. I say we fail to recognize this fact because we are guided too much by that which is past history. We are too satisfied to cling to the old. We must wake up to the fact that contributions to invention are being made for our benefit as well as that of the general public. We must keep ourselves "in-the-know."

Another point we forget is that it takes other engineers to put into practical application the new improvements found by researches. These other engineers in solving the engineering problems involved in putting into practical operation the improvements created by the research engineer, themselves discover new methods of operation and devices that also become inventions.

Doctor Kettering of the General Motors Corporation has stated that we all keep insisting on looking to the past to discover the future, so much, that, "If we drove our automobiles the way we go forward with technical progress, we would put our steering wheel at the rear of the car so we could look out at the road behind to guide us on the road ahead." This comment applies generally to engineers.

The engineering profession must recognize that the new is beneficial to all, and that engineering jobs are primarily dependent upon new developments arising out of inventions. Further it must be recognized that continued adequate financial support for investment by industrial units is needed to pay for such research and to pay for engineering services. Where engineers make themselves a part of a large industrial unit that is involved in new developments, they must help that unit to get paid for their work and for the investments it has made in newly developed products.

THE ROLE OF PATENTS IN INVENTION

Would anyone while working on a research problem, go to his company's competitor and disclose discoveries so that such company could benefit along with his own, without payment for services rendered by him? The answer is obviously that he would not. It is clearly inconsistent for a company to have to turn over free to its competitor the fruits of the discoveries or inventions of its engineers without a period in which to use the results exclusively to compensate for the money invested in the services of its engineers, and the accompanying expense of tools and materials used in the work.

An industrial unit which has the moral courage to hurdle the opposition expressed in rule number 816 should not at the end of the road find the opposition in a position to take away the opportunity for repayment of the investment made.

And how are the investments of a company in its research departments and in the services of its engineers to be protected? That is where the patent system steps into the picture. There can be no argument but that in the past these investments have been protected by the American patent system, and the patents issued thereunder. It is true that industrial organizations do not maintain research for the purpose of obtaining patents. They do it for commercial reasons only. But they could not afford the cost of research for commercial reasons, if they were not protected in their investments.

PROPOSED CHANGES IN THE AMERICAN PATENT SYSTEM

Dive-bomber attacks recently have been waged against the United States patent system. The "ack-ack" that has gone up to meet such attacks so far, has been feeble, but it appears to be increasing in intensity daily. To view intelligently the battleground, it will be necessary to refer to several groups of information and discuss their interrelation.

First, I am convinced that there are changes that can be made in our patent system to improve the technique of operating it and to eliminate the present confusion in the public mind. These changes should be made and this can be done without injury to the national welfare. It would be gross error to contend that the system is perfect. If that position is taken, we would be guilty of applying rule number 816.

However, Judge Jerome Frank, formerly head of the Securities Exchange Commission, and presently a judge of the Second Circuit Court of Appeals, strikes a note on the changing of the patent system that is worthy of attention. In a concurring opinion in Picard versus the United Aircraft Corporation decided in May 1942,

Judge Frank points out that a statutory revision of the United States patent system should not be too drastic. "We should not throw out the baby with the bath water."

Judge Frank bases his reasons for retaining the patent system not as bait for inventors, but as a lure to investors. He points out that it has sometimes been said that there is no need to coax investors thus, because great corporations with their research laboratories will without such bait do the needful. He says the answer is that industrial history discloses that those corporations, at times and to some extent, have been prodded into undertaking such research and into developing improvements because of the threat of competition from occasional outsiders armed with patent monopolies and supplied with funds by a few private enterprisers.

The attacks on the patent system and the defense thereof have principally occurred before the Temporary National Economic Committee and the Senate patent committee. The TNEC was established by Congress in June of 1938 at the request of President Roosevelt to study the concentration of economic power and its injurious effects upon the American system of free enterprise.

Publicity on the aspects of the TNEC hearings affecting patents has been given impetus by the National Association of Manufacturers. Under their auspices George E. Folk has recently published a booklet entitled, "Patents and Industrial Progress." It merits the attention of those who are interested in gaining further knowledge of the TNEC hearings. The NAM has been very active in reviewing and publicizing all angles concerning patents. Edwin B. H. Tower, Jr., president of the Milwaukee Patent Law Association, has done a fine job in keeping in contact with their work. He has also been active in promoting interest in Milwaukee on patent problems and in making suggestions to the NAM and to other interested groups.

I personally attended some of the hearings of the TNEC upon one of my trips to Washington. Some of the most significant statements that I heard were made by Edsel Ford and his attorney, J. I. Farley. Ford and Farley testified that they did not ask royalty for patents that they hold, and that their company could proceed without patents. Mr. Farley, however, emphatically stated that patents were necessary to perpetuate the small manufacturer and to aid the individual inventor. He made the further point that if the small manufacturer had no protection of his investment in his improvement by temporary exclusive use, such manufacturer would not be able to obtain capital to launch his enterprise.

The automobile industry has often been held up as the example of one industry which has more or less eliminated the effect of patents by employing a free cross-licensing system among the members of that industry.

However, it is interesting to note that the original most important automotive advances occurred before the establishment of the cross-licensing system in 1915. In each of the new five-year agreements in 1930 and 1935 entered into by the automobile companies, new patents were not added to the agreement. The reason for this was that the separate companies were expending considerable sums of money in research the results of which they could not afford to contribute by license without a commensurate return.

The Packard Motor Car Company never entered into these agreements. I was present at the TNEC when Milton Tibbetts, of that company, testified. The reason the Packard company did not enter into these agreements, as I recall, was because of their active research program, which they could not afford to contribute. It is a self-evident fact that no company or group can continue to play Santa Claus to competitors who are trying to put them out of business by lowering the price to the point at which no money is left for research.

Before the TNEC, the Justice Department continually maintained that industry has used patents to suppress invention. This type of accusation has appeared again at the recent hearings of the Senate patent committee.

Vanevar Bush, president of Carnegie Institution, Washington, D. C., testified before the TNEC that suppression of patents did not present a serious problem. According to Doctor Bush, never in his experience had he seen a beneficial invention held away from the public. Other qualified individuals supported Doctor Bush in similar statements before the TNEC. The testimony before the TNEC and the more recent hearings of the Senate patent committee failed to disclose any single case of the employment of patents to suppress an invention.

With reference to the recent hearings of the Senate patent committee, testimony on bills introduced into the Senate by Senators Bone and LaFollette on the subject of commandeering patents during the war was originally scheduled to be heard. The hearings, however, were expanded to give publicity in co-operation with the Justice Department to international cartel agreements. In these hearings, the public has been repeatedly presented with alleged abuses in big business, and no effort has been spared to lay such claimed abuses at the feet of the United States patent system.

Confusion on the issues involved has been enhanced by dragging the antitrust laws into the picture. Great fundamental differences exist between the monopolies in restraint of trade prohibited by the antitrust laws and the limited exclusive rights of a patentee under a patent. No distinction has ever been made by the Justice Department. The patent laws and the antitrust laws are founded on sound policy. They both operate to the benefit of the public, but there is a line between them that cannot be defined by geometric definition.

To date, I believe that almost no testimony has been taken directly on the advisability of the bills originally up for consideration before the Senate committee. The testimony that has been taken on international cartels

has shown that instead of United States patents on foreign inventions being used to prevent manufacture in this country, they have, in fact, had the opposite effect.

I had the opportunity to listen to testimony in the Plexiglas case. Many questions were aimed at trying to show that Rohm and Haas of Philadelphia, Pa., had made agreements with German companies which, in the words of the publicity concerning these Senate hearings, constituted "holding hands with Hitler." To me the answers were straightforward and convincing. Rohm and Haas testified that if it had not been for these agreements and the technical information obtained from the German concern, the United States would have been buying its nonbreakable plastic glass for the front-end housings of airplanes from Germany, at the time of the declaration of war on us by Germany. They offered to show that the cost to the Government was close to the cost of production. This information was refused on the basis of military secrets. They then were attacked for the alleged charge of $15 a pound for similar material to make false teeth. After it was shown that only a small fraction of this price got to Rohm and Haas and that most of it was dental industry margins, the questioners still persisted in reading into the record statements about $15 a pound.

Thus it is that in connection with Plexiglas, Carboloy, synthetic rubber, and other products, it has been demonstrated before the Senate patent committee that it was the existence of United States patents on these products that has given the United States companies the basis for obtaining the know-how of manufacture from foreign concerns.

COMPULSORY LICENSING OF PATENTS

The guns of the Justice Department before the Senate patents committee have been directed at big business. The attack in one quarter has been directed toward the enactment of a law under which patents could be licensed by legal compulsion. The theory advanced is that compulsory licensing of patents is necessary as a whip to progress.

This is falacious argument. Absence of an exclusive privilege will prevent the private inventor, or more important, the industrial unit, from obtaining or putting up the speculative capital necessary to finance the long development period of a new invention. Furthermore, those interests with strong financial backing would be enabled by a compulsory licensing law to secure privileges from small inventors or small businesses whose sole economic protection lies in the ability to develop new and exclusive products or processes.

At the TNEC hearings, Mr. Tibbetts, patent counsel for the Packard Motor Car Company was asked by Representative Summers, "Is there a good reason why, upon the payment of a proper compensation, anybody ought not to be privileged to use in his business a novel invention?"

He replied, "The best answer I would have to that is that with small companies, particularly where they rely entirely upon their patents and their exclusive use for the development of that company, if they had to license someone else, they would be out of business; that's all."

A compulsory license in effect destroys investment and does not act as a whip to progress. A company could not stay in business if it received only enough to pay for the expense of its successful inventions. The reason being that other extensive research is necessary to obtain such inventions. It is well known that for every successful research project there are numerous unsuccessful projects. Such expense is not taken into consideration under a compulsory-licensing law and it cannot be evaluated.

I know of a company that was held to infringe a valid patent on a stovepipe joint. Before the case was completed, the engineers of the infringing company brought out a completely new and noninfringing joint that was superior to that of the winning company, and good enough to capture a large proportion of the market sales. In this way, the public is benefited by the progress that was compelled by patents. Such a benefit could not result from a system of compulsory licenses in which competitors could make the same products. The present patent system in the United States acts as a whip to progress by giving protection for a limited term of years to the inventions the other fellow has made.

I know that many times the engineer is tempted to say a patent is nothing but a headache. It stops him from indiscriminately using things, the principles of which he thoroughly understands. He questions whether the patent of the moment expresses invention; for he is often convinced that if his logical mind can comprehend it, certainly it took no invention to create it. He does not stop to ask in borderline cases how well it would be to put that idea back into the mind of the originator and bury them together, and what a loss to the public would result.

In the case where a patent unexpectedly looms up in front of the engineer, he may nearly have heart failure, but he has to jump from that rear steering wheel to one in the front of the car and for a while at least, actually look where he is going. He learns something he seldom learns in school, and that is, to appraise so thoroughly all the angles of the thing in which he is engaged, that he becomes able to create something that not only is as good or better than the patent, but probably new. The patent has whipped him into efforts that produce something for the progress of mankind.

FOREIGN APPRAISAL OF U. S. PATENT SYSTEM

A look at the opinions of other nations respecting the patent system in the United States helps our perspective.

A certain Swiss manufacturer was invited to the Centennial Exposition in Philadelphia, Pa., in 1876. At that time, Switzerland, while a comparatively industrial nation, did not possess a developed patent system. This

Swiss manufacturer, upon his return to his own country, made an address in praise of our patent system and advocated its emulation by the Swiss Government, making reference in his speech to the importance of the American patent system as an aid to industrial progress. In his address, he said:

"I am satisfied from my knowledge that no people has made, in so short a time, so many useful inventions as the American, and if today machinery apparently does all the work, it nevertheless, by no means, reduces the workman to a machine. He uses it as a machine, it is true, but he is always thinking about some improvement to introduce into it; and often his thoughts lead to fine inventions or useful improvements."

Subsequently, the Swiss patent system was established in 1888.

It is worth noting also that Japan looked on the American patent system as a big factor in the greatness of the United States. Prior to 1899, the date Japan established her patent system, a special Japanese official was in the United States to investigate the American patent system. Doctor P. B. Pierce of the United States Patent Office asked this man why Japan wanted a patent system. His reply was:

"I will tell you. You know it is only since Commodore Perry, in 1854, opened the ports of Japan to foreign commerce that the Japanese have been trying to become a great nation, like other nations of the earth, and we have looked about us to see what nations are the greatest, so that we could be like them, and we said, 'There is the United States, not much more than a hundred years old, and America was not discovered by Columbus 400 years ago. What is it that makes the United States such a great nation?' And we investigated and we found it was patents, and we will have patents."

ATTITUDE OF COURTS TOWARD PATENTS

There has been considerable publicity to the effect that the courts are against patents. It must be remembered that in a patent case the court is generally confronted with the bare fact—is there invention? There are no precedents that can positively be relied upon by the court. The statutes do not define invention. The courts are naturally conservative and they view the device from afar, in that a patent case cannot possibly present to them all the background and behind-the-scenes knowledge that surrounds the development of the particular patent.

It is easy for all of us to exercise a better hindsight than foresight. The courts thus often hold that there is no invention because the device to them seems simple and readily made by anyone with ordinary mechanical skill. An engineer, no doubt, on many occasions, has experienced this same sort of feeling in studying an invention developed by another.

I think statistics will bear me out that the courts are no more hostile to inventions and proper patents protecting them, than they are toward workmen's compensation or other cases involving a decision on the facts.

The Supreme Court of the United States which has been accused of taking a decided stand against patents, in the Williams Manufacturing Company versus the United Shoe Machinery Corporation case this past spring, sustained claims of a patent owned by the United Shoe Machinery Corporation and held the same infringed. This indicates in my opinion that the courts are still open minded about patents and the inventions they protect. For the courts to take a prejudiced position would be against the public interests.

At a recent meeting of the American Bar Association, recommendations were officially made by the association directed toward the improvement of the patent system. Whether these are ever actually enacted into law is immaterial. It demonstrates a healthy trend on the part of the association and the patent bar to co-operate in the national movement for the betterment of the patent system.

PATENTS PLANNING COMMISSION

The National Patents Planning Commission was created by President Roosevelt by executive order on December 12, 1941. The order reads in part as follows:

"The Commission is authorized, in conjunction with the Department of Commerce, to conduct a comprehensive survey and study of the American patent system, and consider whether the system now provides the maximum service in stimulating the inventive genius of our people in evolving inventions and in furthering their prompt utilization for the public good; whether our patent system should perform a more active function in inventive development; whether there are obstructions in our existing system of patent laws, and, if so, how they can be eliminated; to what extent the Government should go in stimulating inventive effort in normal times; and what methods and plans might be developed to promote inventions and discoveries which will increase commerce, provide employment, and fully utilize expanded defense industrial facilities during normal times."

In announcing the appointments of Doctor C. F. Kettering, Owen D. Young, Chester C. Davis, Edward F. McGrady, and Francis P. Gaines to the Planning Commission, the secretary of commerce said in part:

"The Patent Planning Commission can, in my opinion, perform a really useful service in postwar planning . . . . For more than a century American industrial development has been encouraged, inventions have been stimulated, and both industry and our people have benefited by the protection which our patent system has afforded American genius. There is reason to believe that a survey of existing facilities and procedure, a study of future needs and the challenge to American inventive effort, undertaken by the Commission in conjunction with the Patent Office, may produce even greater results."

The Patents Planning Commission is composed of competent members. Whether the Commission will function to promote the economic and technical well-being of the country or sink into ineffective mediocrity, will depend largely on the prevailing atmosphere of public interest and opinion in its work.

Headlines have announced the presentations of the Department of Justice before the Senate committee on patents, but the day-by-day achievements of the Justice

Department in proposing helpful changes to the patent system and the steps to take to promote invention are unchronicled because there are none. The friction between the Justice Department and business, the department's taste for scandal, and its preoccupation with personalities, make us realize that the department can only act as a springboard to encourage action by others better qualified to act.

The public is surprisingly uninformed of the extent to which the patent system has contributed to the public good and the activities of the Justice Department do not present the patent system in the proper light. The podium of the Patents Planning Commission is the stage upon which the true facts can be brought to the public.

Engineers can help the Patents Planning Commission and the general public by working through their respective technical and professional organizations and their committees to convey to the commission interest in the investigations and findings of the commission, with respect to inventions and patents. Engineers should hold themselves ready to give assistance when called upon so to do, and to present helpful suggestions through their committees, if such action seems appropriate.

All are agreed that the country needs not less but more of that which has enabled it to outstrip other nations industrially. The National Patents Planning Commission may find ways of making the patent laws even more effective in the future economy of the United States.

CONCLUSION

We believe in competition, in the excitement of conflict, and the testing of man against man in a fair fight. In the economic system of the United States, the dynamo is self-interest—a self-interest which may range from mere petty greed to admirable types of self-expression.

The patent system protects the powerful drive of self-interest and in doing so promotes the general welfare. For most of us as engineers self-interest is centered in more income and greater recognition and standing in our industrial unit and our profession. The patent system makes it possible for this self-interest to be nurtured by protecting industrial units in their investments in us. Without such protection as the patent system offers, it would be a wary penny indeed that would find its way into the very things upon which our livelihood depends. Patent protection for a company is protection for their engineers because it enables the company to finance the engineers' work.

What we produce in trying to circumvent competitors' products not only helps our standing in the industrial unit where we are employed and establishes our income, but it promotes the general welfare of everybody as well, because we have produced something new. We have added to that body of knowledge which helps all of us to better enjoy the world we live in. The patent system forces the engineer to produce these new things. Greater progress is made this way than would be possible if one competitor could take over another competitor's product.

The patent grant is in line with the American system under which remuneration is given for accomplishments. Without individual remuneration in some fair proportion to accomplishment, it cannot be hoped that we as a nation will progress in the future.

We, as engineers, must maintain an open mind and liberal view toward the methods employed to continue and to encourage invention. The patent system has proved eminently successful in the past in promoting invention, and in giving us the protection we need in seeking our livelihoods. Let us, therefore, not throw away the staff that enabled us to reach the top of the hill; instead, let's build our house around it.

Mr. Kettering at a recent meeting of the American Bar Association in Detroit told the following story. At one time as a manager of a plant, he put on a campaign to reduce the amount of scrap produced. The departments were caused to bring all the actual scrap into the yard and pile it in a heap. This pile grew until it was very impressive, and great attention was directed to the problem of scrap. The organization, in fact, didn't do much else and a board of department executives met almost daily on the subject.

Finally a smart foreman took a photograph of the immense scrap pile which had been accumulating over a period of six months. He then enlarged this photograph to the proportionate size of the metal going into the finished products and placed the photograph and its enlargement side by side on the wall of the meeting room. He proceeded to point out in open meeting how they had been devoting their time to only $^1/_2$ of one per cent of the total volume of steel used by the company and that the $99^1/_2$ per cent fine products being produced were more important and deserved greater attention. He further pointed out that they should not set their sight so exclusively on the incorrect that they be blinded to the beneficial utilization of the whole.

And so it is that some groups in our nation have directed the attention of engineers and that of the general public to the scrap pile of the patent system. They have dramatized and glossed that scrap pile to such an extent that we can only see bad features in the system. They have made us forget the good in the patent system that far outweighs the bad. They have made us forget that the inventive advances of this country are predicated on patents. And worse, they have made us forget that our very jobs as engineers rest upon a patent system that protects either our own or our company's investments in our work.

We have been lulled into inactivity too long by indifference, by lack of knowledge and misinformation. Let us now, while we are still masters of our fate, lift our eyes from the scrap pile that has been placed before us and look upward to build around and to improve the laws that have made the United States outstanding as an inventive nation, namely, the American patent system.

Power-Line Transposition Practices

F. VON VOIGTLANDER
MEMBER AIEE

This brief exposition of the purpose and efficacy of transpositions in power lines, originally prepared for the engineers of a large midwestern power system, should be of interest to other power-system engineers and communication engineers as well.

POWER-LINE transpositions often have been regarded as nothing less than chicanery and electrical sleight of hand, chiefly because the fundamentals on which their design is based have not always been clearly understood. Transpositions are installed in power lines in which all conductors normally operate at substantially equal potential between phases and to ground, and carry current of equal magnitude and symmetrical phase displacement, for the following reasons:

1. To balance the capacitance of three-phase conductors with respect to ground so as to minimize the characteristic residual voltage of the system.

2. To balance the three-phase conductors with respect to exposed communication conductors, that is, to co-ordinate communication-circuit exposures in which excessive longitudinal induction due to balanced components might otherwise be experienced.

The function of transpositions is essentially to change the phase of induction between two systems of conductors in a mutual electric field, or to balance a system of conductors so as to equalize their capacitances to earth. Transpositions are necessary because of the impracticability of achieving geometrical, and hence electrical, symmetry in commercial open-wire-line systems.

In the past, power lines often were transposed only at the request of communication companies, often without justification, and sometimes in lieu of proper transpositions in signaling circuits. When such signaling circuits subsequently were properly transposed, the influence of power-circuit transpositions frequently was then found to be negligible, tending to the conclusion that power-circuit transpositions were of little value. However, where signal conductors are subject to excessive longitudinal induction, and are otherwise well designed and maintained, power transpositions may be an aid to co-ordination. Each case should be analyzed on its own merits and transpositions should be installed only where they are unquestionably justified. Care should then be exercised in the design; they should not be placed at unreasonably short intervals, as an excessive number of transpositions adds little to their effectiveness, and the simple condition of crossing phase conductors creates potential service hazards and maintenance complications.

BALANCING A POWER SYSTEM TO GROUND

The importance of a good balance to ground on high-voltage transmission systems has frequently been underestimated, with the result that many lines have been indiscriminately transposed or not transposed at all. On systems having grounded neutrals, whether direct grounded or impedance grounded, the normal residual current circulating through the system can be minimized by maintaining a good balance to ground. Since residual circulating current is of no benefit to the power system, proper balancing of the lines to ground so as to limit such current to a reasonable minimum is desirable, as it will mitigate a common cause of inductive disturbances. Modern design of transposition structures eliminates to a large extent the difficulties formerly encountered due to short circuits caused by ice loading and unloading, and to flashovers permitted by inadequate structural clearances.

In systems of such magnitude that electrical resonance or near resonance is encountered at critical frequencies, transpositions will help in limiting residual voltages of these critical frequencies; this will limit the residual current circulating in the system. With systems grounded through resonant neutral-grounding reactors, transpositions may be necessary to prevent current circulating continually through these devices in excess of their thermal ability.

In order that a power system may maintain a reasonably good balance to ground, it is believed desirable that each line section by itself be transposed to give as good a balance as feasible, though it is necessary to consider the entire metallically connected system as a whole to determine the system ground balance. For power lines operating at 60 cycles, transposition "barrels" about 50 miles in length should prove satisfactory where no specific co-ordination is required. The length of the power line or the extent of the power system in general would not influence the length of barrels required, but in some cases extensive systems might require extra transpositions to mitigate the effects of cumulative unbalances due to variations in configuration, and other factors. It should be borne in mind that transpositions can be effected by merely rearranging the phase order of the lines at switching stations and may not require actual "rolling" of the line conductors.

Transpositions become more important with higher operating voltages because the residual currents then usually become greater. Since the higher voltage sys-

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tems are usually of greater geographical extent, the influence of their residuals may become correspondingly quite widespread.

CO-ORDINATION WITH SPECIFIC COMMUNICATION EXPOSURES

Both telephone and telegraph circuit exposures may be benefited by power-line transpositions. However, the co-ordination requirements of these two types of communication facilities may be quite different. For the purposes of this discussion, only the common type of telephone and telegraph systems will be considered, that is, metallic voice-frequency telephone circuits, and ground-return d-c telegraph circuits.

Telephone-Circuit Co-ordination. Power-line transpositions are generally of little value in telephone-circuit noise co-ordination. They should be considered only where excessive longitudinal induction at voice frequencies from balanced components is being, or may be, experienced. Because of the frequency-response characteristics of the human ear and ordinary telephone equipment, noise induction at fundamental frequencies is of no importance; but the harmonics, especially the triples, are of great consequence, particularly in the range from 180 to 2,200 cycles.

The effects of ordinary power induction on telephone-circuit noise can usually be mitigated effectively by proper telephone-line transpositions and maintenance of both power- and telephone-circuit electrical balance. However, in cases of excessive longitudinal induction, noise may be caused by reason of unbalanced impedances in the telephone circuit, even though they are balanced to the best commercially practicable limits. In these special cases, power-line transpositions specifically designed to co-ordinate with a proper telephone-transposition layout can offer some relief. Such power-line transpositions must also be co-ordinated with any others installed for the purpose of balancing the power line, as the indiscriminate addition of transpositions may adversely affect an existing balance to ground, thereby causing an increase in residual current which could result in more harm than good.

Telegraph-Circuit Co-ordination. The use of ground return precludes the effective use of communication-circuit transpositions for the inductive co-ordination of d-c telegraph circuits. As the rate at which the current flow is interrupted in commercial telegraph circuits corresponds roughly to 25 to 60 cycles per second, these circuits are quite vulnerable to induction at fundamental power-system frequencies. Furthermore, the use of ground return causes the longitudinal induction to flow through the same path as the signal current, resulting in false and garbled signals. Power-line transpositions are therefore quite effective in telegraph co-ordination in limiting longitudinal induction from balanced components and in balancing the power system to ground to limit normal residual induction. Such transpositions must be co-ordinated with the power-system transposition scheme and sometimes with telephone circuits carried on the telegraph lead. Ordinarily, transposition barrels less than three miles in length should never be required, and generally they can be much longer.

Engineering Auditorium Lighting Improved

S. W. BRUUN
ASSOCIATE AIEE

THE illumination of the auditorium in the Engineering Societies Building has been for several years the subject of study at the request of United Engineering Trustees, Inc., by Institute members specializing in lighting. Increased daytime use of film and slide projection had been hampered by daylight filtering through roller shades and the interior illumination had been pronounced obsolete, inadequate, and difficult to maintain. In an effort to improve the building facilities for their Founder Societies and associates, the board of trustees of United Engineering Trustees, Inc., undertook the modernization of this meeting hall and authorized the replacement of the false skylights with a more permanent boarding and a thoroughly modern lamp system.

The old lighting installation consisted of 3 large and 6 smaller false skylights above which were mounted a total of 692 25-watt lamps giving an average of one half foot-candle. Access for maintenance to the skylights was through the ducts of the ventilating system, by no means an easy task. Requirements for the renovation were: lighting equipment designed for ease of maintenance both in relamping (to be done from the floor—the auditorium is 42 feet high and has a balcony on three sides) and elimination of dust-catching nonessentials; of a design which would be in harmony with the archi-

The front cover of this issue shows the auditorium of the Engineering Societies Building with its new illumination.

S. W. Bruun is an illuminating engineer with the Rambusch Decorating Company, New York, N. Y.

Table I. Comparison of Old and New Lighting in the Engineering Societies Auditorium

Lighting	Total Watts
Old installation	
9 false skylights (692 25-watt lamps)	17,450
6 wall brackets (18 25-watt lamps)	450
Total	17,900
Average illumination 1/2 foot-candle	
New installation	
4 Rambusch Annulites (300-watt silver-bowl lamps) / 16 Rambusch Annulites (150-watt silver-bowl lamps)	3,600
10 wall brackets (75-watt lamps)	750
Total	4,350
Average illumination 8 foot-candles	

tecture of the room; and an efficiency which would deliver more light and at the same time be more economical in current consumption.

Downlighting, in combination with a moderate amount of indirect lighting, was accepted as the solution and a series of Rambusch Annulites, a highly efficient form of downlighting unit, was installed in the plasterboard panels which replaced the glass skylights. The majority of the Annulites are totally recessed and can be relamped from the balcony by means of lamping rods. Four semiexposed 300-watt units which light the main seating area are equipped with automatic cutouts and can be lowered to the floor. The Annulites are all metal. The light is projected through an annular aperture from precision reflectors plated with pure gold. The indirect lighting is supplied by wall urns of appropriate design mounted on wall panels and balcony front. No changes were made in the stage and under balcony lighting.

Against the one half foot-candle average of the old lighting installation the new installation furnishes an average of 8 foot-candles. The accompanying table shows some interesting factors about the old and new lighting. With one quarter the consumption of the old installation, the new lighting has improved the illumination 16-fold and the efficiency 6,400 per cent.

Organic Plastics as Insulating Materials

JOHN DELMONTE
ASSOCIATE AIEE

Recent developments in new types of plastics and improved manufacturing techniques of older types are enabling these materials to assume an increasingly important role in the field of electrical insulation. Their electrical characteristics are reviewed here.

ORGANIC-plastic materials are playing increasingly prominent roles as solid dielectric materials. Their new importance is marked by recent developments of new types of plastics, as well as by improved processing and manufacturing techniques of earlier types. Familiarity with electrical properties of plastics and forms in which they are made available is of considerable advantage to electrical engineers concerned with insulating problems.

While plastic materials are contributing to the high quality of electrical insulation, the plastics industry is in a like measure indebted to the electrical industry for the semiautomatic and fully automatic control features of the most recent types of molding machines. The more progressive custom molders of plastics recognize the need for skilled electrical engineers in designing and maintaining these equipments so necessary for efficient production.

Types of plastics with respect to their origin, the particular significance they have in the electrical field, and representative trade names of plastics are indicated in Table I.

A further classification for plastic materials other than that appearing in Table I is based upon the response of the materials to thermal influences. The two major groups are:

Thermoplastic. Capable of being softened by heat and pressure an indefinite number of times.

Thermosetting. A material which undergoes chemical and physical changes to become permanently infusible and insoluble.

VARIOUS FORMS IN WHICH PLASTICS ARE AVAILABLE

As electrical insulating materials, plastics are made available in various forms:

Molded. The largest portion of plastic materials are molded under heat and pressure from a granular or powdered form to a solid body combining good physical and electrical properties. Metal inserts are often included in the assembly during molding to obtain a composite body in one operation.

Laminated. Aside from molded forms, the laminates are best known as insulating materials. Phenolic-resin impregnated paper or cloth bases are laminated under heat and pressure to form standard-size sheets, rods, and tubes. Representative electrical insulation fabricated from these are shown in Figure 1. Terminal strips, washers, radio tube bases, or any insulation combining high

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Table I

Material	Representative Trade Names	Representative Electrical Applications or Properties
Synthetic resins		
Phenol or cresol formaldehyde	Bakelite, Durez, Textolite, Micarta, Insurok, Formica, Synthane, Makalot	Molded and laminated electrical equipments of every description. Enjoys the greatest consumption among plastics
Urea or thiourea formaldehyde	Plaskon, Beetle	Light-colored, decorative characteristics
Melamine-formaldehyde	Melmac	Newer composition possessing good dielectric properties
Glyceryl phthalates	Alkyds, Glyptals	Insulating lacquers of every description
Polymethyl methacrylate	Lucite, Plexiglas	Good insulation properties—transparent enclosures
Polystyrene	Styrene, Styrol	Best dielectric properties
Polyvinyl chloride-acetate	Vinylite	Excellent dielectric properties
Polyethylene		Excellent dielectric properties
Polyvinyl formal	Formex	Electric wire insulation
Polyvinyl chloride	Koroseal, Flamenol	Electric wire insulation
Cellulose Derivatives		
Cellulose nitrate	Celluloid	High flammability
Cellulose acetate	Tenite I, Plastacele, Lumarith, Vuepak	Various insulating foils and molded shapes
Cellulose acetate-butyrate	Tenite II	Various molded and extruded forms in electrical applications
Ethyl cellulose	Ethocel	Good insulating properties. Foils and lacquer
Natural Resins and Proteins		
Rosin, copal, amber, dammar gum		Useful as modifying agents in lacquer formulas
Bitumen	Cetec, Gilsonite	Cold molded insulation, switch plates, arc-resisting parts
Lignin		Various insulating panels and boards
Casein, zein, soybean protein		Various uses as surface coatings and adhesive agents

mechanical strength with good dielectric properties are best prepared from laminated plastics.

Films or Foils. Thin insulating films or foils, prepared from solutions of plastic materials, may be used in motor insulation, wrapped capacitor construction, or wire insulation. The materials may be applied on a cloth or paper base or else as 100 per cent plastic. Ethyl cellulose, cellulose acetate, and polystyrene, best known in these forms, are available as foils ranging from 0.001 inch thick up.

Extruded. Plastics may be extruded in form of continuous conduits or insulating sleeves, or else applied directly over the outside of electric conductors. Extruded sleevings of polyvinyl resins are largely replacing varnished cambric tubings among electrical manufacturers. Possessing greater uniformity and superior dielectric properties, they retain their characteristics indefinitely. Substantially permanent flexibility and nonaging qualities are other reasons why plasticized polyvinyl chloride sheaths will replace much of the rubber insulation for wires.

Impregnating Varnishes. Various plastic materials derived from synthetic and natural resins and cellulose derivatives are used in treating metal and wood surfaces, or else final assemblies like wound motor armatures. Where good heat resistance, strength, and good dielectric properties are required, baked glyceryl phthalate (Glyptal), or cashew-nut shell oil-formaldehyde resins (Harvel), are used for impregnating purposes. Plasticized thermoplastic

Table II. Electric Properties of Plastics

Material	Dielectric Strength* (Volts Per Mil)	At 1,000 Kilocycles: Power Factor (Per Cent)	At 1,000 Kilocycles: Loss Factor (Average)
Phenol formaldehyde:			
Wood-flour-filled, molded	300–500	3.5–6.0	0.1–0.5
Low-loss types, molded	200–400	0.7–0.8	0.03
Paper base, laminated	400–1,200	3.0–5.0	0.1
Fabric base, laminated	200–600	2.0–8.0	0.2
Asbestos base, laminated	100–300	15–20	0.8
Urea formaldehyde, molded	400–600	2.8	0.05
Polyvinyl chloride-acetate, filled	350–400	1.7	0.2
Methyl methacrylate, molded	170–500	1.5	0.045
Polystyrene, molded	500–700	0.01	0.0002
Polyvinyl formal		2	0.058
Polyvinyl chloride		1.7	0.056
Rubber		0.6	0.0025
Cellulose acetate sheet	600–950	3–4	0.030
Isolantite	300–500	0.4	0.025
Fused quartz		0.0022	0.00009
Electrical glass		0.60	0.057

* Dependent on thickness and temperature.

Table III. Comparative Dielectric Strengths

ASTM 60-Cycle Tests on $^1/_{16}$-Inch Materials

Laminated Phenolic Material	Dielectric Strength: Short-Time 25 C	Short-Time 100 C	Step-by-Step 25 C	Step-by-Step 100 C
Paper (*X*, *XX*)	700	500	500	350
Asbestos (*A*)	225	100	135	75
Light-weave fabric (*LE*)	500	400	300	200
Heavy-weave fabric (*CE*)	500	400	300	200

formulas are also valuable, though dielectric properties suffer sometimes through plasticizer additions.

Cast Forms. Less frequently heard of, though becoming increasingly important, are cast forms of organic plastics. Phenolics and melamine formulas are available, the latter possessing superior dielectric properties. Small productions are being fulfilled by cast articles, benefiting from the absence of expensive steel molds ordinarily required for molding.

ELECTRICAL PROPERTIES OF PLASTICS

Electrical properties of plastics are dependent upon the conditions of manufacture as well as the conditions of service, and, in order to apply plastics intelligently, disadvantages as well as advantages should be studied.

Dielectric Strength. Representative values of dielectric strength of plastics are shown in Table II.[1] These are typical test values (American Society for Testing Materials) upon discs four inches in diameter and one-eighth inch thick. At thicknesses of 0.001 inch or thereabouts, thin foils from plastics show a marked dependence of kilovolts per mil upon material thickness. Doctor Bass first reported a peak in the curve for ethyl cellulose[3] which is reproduced in Figure 2. Values of 3,000 to 4,000 volts per mil are not uncommon for polystyrene, ethylcellulose, and cellulose acetate foils about 0.001 inch thick.

The high values of dielectric strength ranging from 3,000 to 4,000 volts per mil for thin foils are of fundamental importance to capacitor manufacturers, because they will permit the introduction of greater capacitance in a given volume, without decreasing the test breakdown-voltage requirements.

Most plastic materials are affected more or less by temperature and by moisture. Dielectric strength may be expected to show some variation in this direction. Representative values for thermosetting laminated phenolics are given in Table III for two different temperatures, 25 degrees centigrade and 100 degrees centigrade. Specific data on methods of test are outlined in the ASTM Specification *D*-149-36*T*. Short-time dielectric-strength step-by-step methods of test, and endurance dielectric-strength methods anticipate probable service conditions. Short-time test methods, giving highest values, are preferred and most frequently employed in applying routine proof tests to electric appliances.

In general, organic plastics do not offer much difficulty with respect to dielectric strength, because if there is ample wall thickness to meet mechanical requirements, there is generally more than adequate material to offer sufficient resistance to penetration by high voltages. In fact, any difficulty encountered in these respects is largely due to:

1. Faulty design.
2. Imperfections arising during manufacture.
3. Foreign matter in the plastic.

For example, dielectric breakdown over the surface is much more common than through the material. This is more often a problem of design. As for faulty manufacture, it is well known that cracks or breaks in molded plastics contribute to dielectric failure, rather than the material itself. This point has become even more significant in recent years in connection with injection-molded articles. The writer has observed in numerous injection-molded coil bobbins that the dielectric strength of a plastic material is substantially lower in the vicinity of a weld mark at which there exists a nonhomogeneous blend of molding material.

Plastic materials are often modified with reagents, known as fillers and plasticizers, for the purpose of improving physical properties such as impact strength and toughness. However, the fact must not be overlooked that in attaining these properties dielectric qualities may be sacrificed. It is well known, for example, that most plasticizers will substantially reduce the dielectric strength of the pure plastic. In most cases a compromise must be reached between electrical and mechanical properties.

Certain transparent plastic materials also lend themselves to the analysis of electrical breakdown in solid dielectric *prior* to the actual failure. In Figure 3 a section through a transparent plastic with electrodes spaced at a fixed distance is shown. As the voltage is raised, a point is reached where a stress pattern is formed (when viewed in polarized light), giving evidence of mechanical failure before electrical breakdown, which may be seen in the last stage. There a carbonized path has burned through the material. This photodielectric method of analysis is comparable to the photoelastic method of studying mechanical structures, with the aid of transparent plastics and polarized light. This technique has recently been developed by the author for observing visually dielectric breakdown.

Insulation Resistance. Plastics, like other insulating materials, exhibit a high resistance to the passage of electric currents. Whereas the resistance of a good metal conductor may be of the order of 10^{-6} ohm-centimeter, the resistance of a good insulator will be of the order of 10^{16} ohm-centimeters. Such quantities are difficult to measure with a high degree of accuracy, and the variations in insulation resistance over a given sample of material are usually of such magnitude as to obviate the development of more accurate instruments. Measurement may be broken down into volume and surface resistance, described as follows:

Insulation resistance between two electrodes is the ratio of the

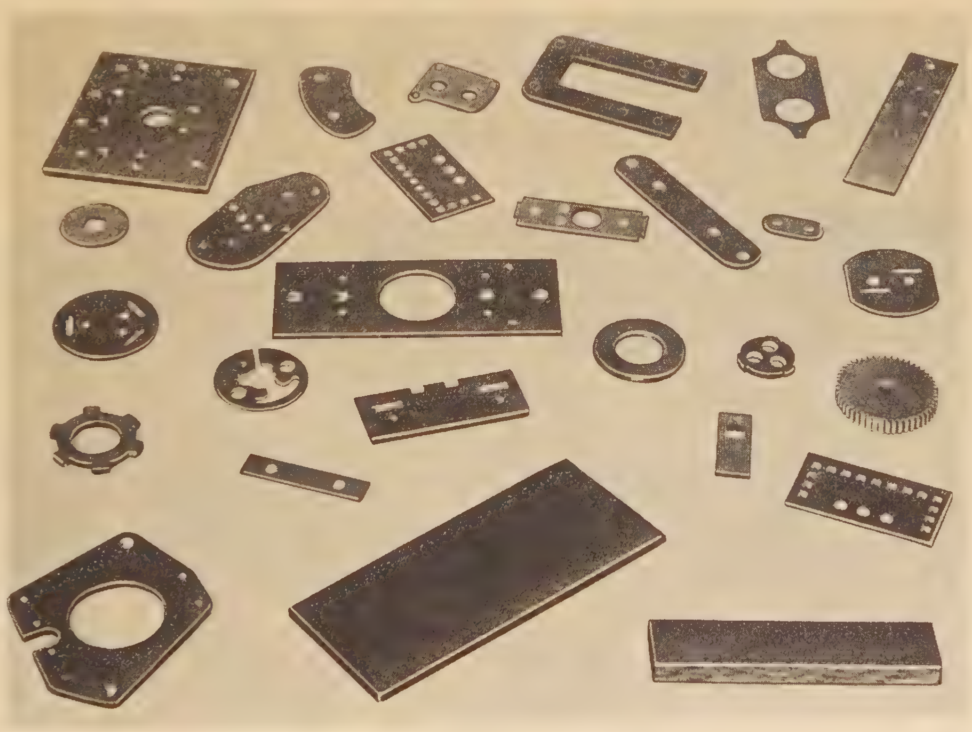


Figure 1. Representative electrical insulation parts fabricated from laminated phenolic plastics

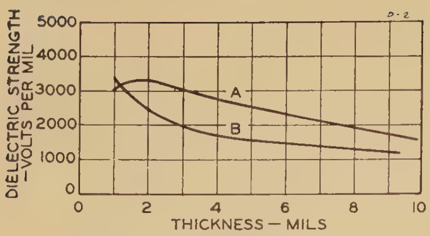


Figure 2. Dielectric strength as a function of thickness of Ethocel

Short-time ASTM 149–36T data by Bass-Goggin

A—3 days at 21 degrees centigrade; 50 per cent relative humidity

B—24 hours at 22 degrees centigrade in water

voltage applied to the electrodes to the total current that leaks between them.

Volume resistance is a measure of the ratio of applied electromotive force across a volume of insulating material to the current that flows only through this volume.

Representative values of insulation resistance are given in Table IV. Quite outstanding are plastic materials like polystyrene. Problems of insulation resistance are of vital concern to all electrical manufacturers, where electrical leakage may affect the serviceability of the apparatus. However, the engineer may not rely fully upon data such as appear in Table IV. Temperature exerts quite a decided influence upon insulation resistance, as the curves in Figure 4 will illustrate. These data were taken from a paper by Doctor Zinzow.[4] Of particular interest is a molding compound like *BM*-262, developed for its good dielectric properties. It is a considerably better dielectric than some of the general-purpose molding. When excellence in dielectric properties is desired, it is better to consult the materials manufacturer rather than make a random choice.

Surface insulation resistance depends a great deal upon manufacturing conditions as well as operating environment. The highest resistance values observed in plastics are those in which a good surface gloss and low water absorption are evident. Dull uneven surfaces will accumulate dirt and dust impurities, and the surface resistance of molded or laminated parts will drop sharply.

There are certain conditions under which a low surface insulation resistance may be desired, as on aircraft, where plastic enclosures are to derive the benefit of electrostatic shielding. Various methods have been worked out for electroplating the surface of plastics. In these combinations there are singular advantages in the integral assembly of a continuous metal shield and a plastic material as base.

Arc Resistance. Not too much data exist on the arc resistance of various plastics. An ASTM testing specification (*D*495-38*T*) suggests arcs of known current and

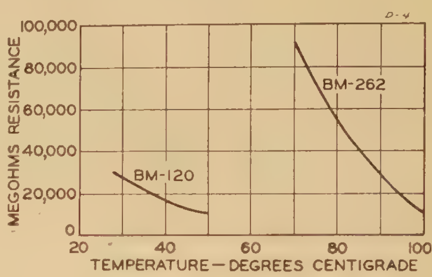


Figure 4. Influence of temperature on insulation resistance

Data by Zinzow

controlled frequency to induce failure. Materials such as phenolics are relatively poor performers in the presence of power arcs. These materials will carbonize fairly readily, and, once the carbonized path has been established, the material has lost its usefulness as an insulator. However, thermoplastic materials such as acrylates, polystyrene, and cellulose derivatives will be scarred across their surfaces by intense arcs, but their continued usefulness is not generally impaired.

Good arc-resisting properties are possessed by cold-molded bitumen-base plastics and shellac plastics. The former possess high water absorption and low surface insulation resistance, but nevertheless are outstanding in their resistance to arcs. Switch and circuit breakers

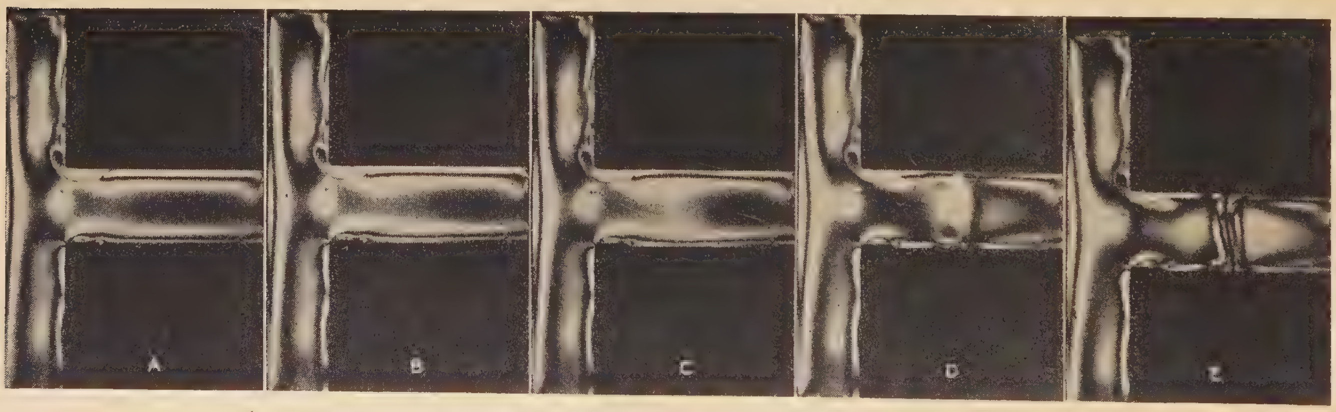


Figure 3. Photodielectric analysis of a section through a transparent plastic with electrodes spaced at a fixed distance

One-fourth-inch gap *One-eighth-inch-diameter rod*

A—At start—zero voltage *B—To 8,700 volts in 5 seconds and return* *C—To 10,800 volts in 5 seconds and return* *D—To 12,100 volts in 5 seconds and return* *E—Failure at 13,000 volts within 3 to 2 seconds*

Table IV. Insulation Resistance of Insulating Materials

25 Degrees Centigrade

Material	Ohm-Centimeters
Phenol formaldehyde	10^{10}–10^{13}
Urea formaldehyde	10^{13}
Methyl methacrylate	10^{15}
Polyvinyl chloride acetate	10^{14}
Cellulose acetate	10^{12}
Polystyrene	10^{17}–10^{18}
Rubber	10^{15}–10^{16}
Glass	10^{16}
Fused quartz	10^{18}

frequently employ these materials, as well as vulcanized fiber, for effective general-purpose type of insulation. For high-strength plastics combining good dielectric properties the laminates are quite acceptable.

Dielectric Constant. The dielectric constant of most plastic materials does not vary much over the range of available frequencies, except in certain examples where polarization effects at interfaces of fillers and resin molecules become high. In general, nonpolar molecules such as polystyrene do not vary much in dielectric constant when varying from lower frequencies to high radio frequencies. Table V outlines representative dielectric constants for different plastics; the data was collected from various sources.

While low values of dielectric constants are not of much significance to capacitor manufacture, changes in these constants are quite important to theoretical analyses of the plastic materials. For example, plastics with definite polar properties have been shown by Morgan and Yager to have dielectric constants varying with frequency.[5] A portion of their curves is reproduced herewith (Figure 5). For comparison purposes, nonpolar molecules of polystyrene and polyethylene are included. It is also interesting to observe that nonpolar molecules appear to have lower dielectric constants.

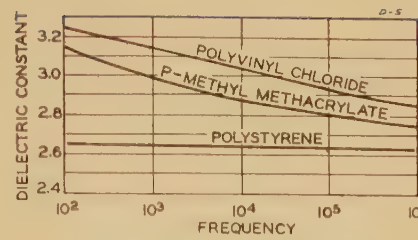
Dielectric constants depend not only upon temperature

Table V. Representative Dielectric Constants

Material	At 60 Cycles	At 1,000 Cycles	At 1,000 Kilocycles
Phenol formaldehyde:			
Molded, mineral	5–20	5–20	5–20
Molded, wood-flour-filled	4.5–12	4–8	4.5–8
Molded, fabric-filled	5–10	4.5–6	4.5–6
Laminated, paper base			4.5
Laminated, fabric base	5–7		4.5–6
Phenol furfural, molded	4–7.5		5–7.5
Urea formaldehyde, molded	7	6.4	5.8
Polystyrene	2.6	2.6	2.6
Cellulose acetate	5–7.5	6.8	4.2–6.2
Cellulose nitrate	6.7–7.3	6–7	6.1
Polyvinyl chloride-acetate		3.1	2.9
Methyl methacrylate	3.4	3.1	2.8
Ethyl cellulose	2.9–3.3	3.2	3.2
Polyvinyl chloride		3.2	2.9
Rubber hydrochloride		2.5	2.5
Chloroprene		7.8	6.7
Shellac	3.1		
Isolantite		6.1	6
Fused quartz		4.1	4.1
Hard rubber	2.8	2.9–3.1	3.1
Air	1	1	1

Figure 5. Dependence of dielectric constant on frequency

Data by Fuoss



and frequency but also the composition. Considerable time has been spent by Doctor Fuoss in investigating plasticized polyvinyl-chlorides.[6] His data indicate higher dielectric constants for increasing proportions of tricresyl phosphate plasticizer in proportion to the polyvinyl resin. Much valuable research is in progress in this field in an effort to ascertain fundamental relationships between chemical structures and electrical properties.

Power Factor. Of paramount concern to radio and wireless engineers are the power factors of the insulating materials. As a measure of the power absorbed by the material in an a-c field, the power factor is a convenient means of differentiating between the various plastics. Considering all types of insulating materials, several plastics are quite outstanding in their low power factors. Polystyrene, polyethylene, and "low-loss" phenolics behave well in this connection.

The power factors and loss factors of plastics must be considered not only in the light of their observed values at room temperature but also under service conditions where they are subject to mechanical and temperature stresses. It is imperative in specifying and applying plastics that full importance be attached to these details if their application is to prove successful.

Precision capacitors, coil forms, and insulator supports may be molded of a "low-loss" phenolic which is prepared from a high mica-filler content. Outwardly, molded articles from this grade of material are characterized by a yellow-brown color. In some equipments, molded polystyrene insulating parts are preferred. These plastics are also available in lacquer form which may be applied to the outside of insulating bushings for electric connections.

The presence of water or conducting impurities in the dielectric tends to yield higher power factors. In general, the better insulating materials among the plastics are those possessing the lowest water absorption. Polystyrene with practically zero water absorption is best among the insulating materials.

REFERENCES

1. Plastics in Engineering (second edition), **John Delmonte.** Penton Publishing Company, Cleveland, Ohio, 1942.

2. American Society for Testing Materials Standard -D147-39*T*.

3. Preprint 74-36, **S. Bass, W. Goggin.** Electrochemical Society *Transactions*, October 12, 1938, page 559.

4. Paper presented at Museum of Science and Industry, **Zinzow.** April 1938.

5. **Morgan, Yager.** *Industrial and Engineering Chemistry*, volume 32, November 1940, page 1519.

6. **Fuoss.** *Annals* of the New York Academy of Science, volume 40, December 1940, page 429.

INSTITUTE ACTIVITIES

Program Announced for National Technical Meeting, January 25–29, 1943

Conservation of materials by getting the most out of existing equipment will be the particular objective as an aid to the war effort for the AIEE national technical meeting to be held in New York, N. Y., January 25–29, 1943. On Thursday, January 28, the Institute of Radio Engineers will hold a meeting concurrently in both morning and afternoon. In the evening a joint AIEE–IRE meeting will be held, at which there will be an address on "Ultrahigh Frequencies" by Doctor G. C. Southworth of the Bell Telephone Laboratories, Inc. Both meetings will be held in the Engineering Societies Building. In accordance with AIEE wartime policies (*EE, Sept. '42, p. 477*) all programmed social activities have been omitted. It is hoped, however, that there will be opportunities for members and guests to get together during the meeting.

The general session will feature the important topic of "Technical Man Power Requirements As an Aid to the War Effort." Prominent speakers will present both the military and industrial phase of this subject.

MEDAL PRESENTATIONS

The Edison medal, John Fritz medal, and Hoover medal, will be presented on Wednesday evening, January 27.

The Edison medal was awarded to Major Edwin H. Armstrong (*this issue, p. 27*) "for distinguished contributions to the art of electric communication, notably the regenerative circuit, the superheterodyne, and frequency modulation."

As previously announced, the John Fritz medal was awarded to Doctor Willis R. Whitney (A '01) (*EE, Nov. '42, p. 574, 582*) "for distinguished research, both as an individual investigator and as an outstanding and inspiring administrator of pioneering enterprise, co-ordinating pure science with the service of society through industry."

The Hoover medal was awarded to Gerard Swope (F '22) (*EE, Nov. '42, p. 574–5, 582*) with the following citation: "engineer and distinguished leader of industry, ever deeply interested in the welfare of his fellowmen, whose constructive public service in the field of social, civic, and humanitarian effort has earned for him the Hoover medal for 1942."

TECHNICAL SESSIONS AND CONFERENCES

To carry out the principal theme of conservation of materials by good engineering practice three more proposed guides have been developed in co-operation with the standards committee. These guides are in addition to the guide for overloading transformers and voltage regulators (AIEE *Transactions, volume 61, 1942, September section, pp. 692–7*). They treat the selection of electric motors and motor controllers, recommendations for application and operation of circuit breakers and switchgear, and industrial power distribution systems. Each proposed guide will be presented and discussed in a separate conference on respective subjects. In addition, two other memoranda dealing with emergency measurements to increase output of generating equipment and generating systems will be presented and discussed in a conference on power generating equipment. It is expected that these memoranda will later be put into the form of reports for issuance as guides at a subsequent meeting.

Other sessions and conferences which will have to do with getting the most out of existing equipment deal with capacitor generators and transformer loading, emergency loading of transmission systems, emergency rating of power cables, electronic tubes, and substation designs to meet wartime conditions. Others which are planned as aid to the war effort deal with defense lighting, wartime engineering education, transformer loading, and analysis of military loads and postwar application.

REGISTRATION AND HOTELS

All AIEE members who have received an advance registration card should fill in and mail the card promptly. Upon arrival at the meeting a member who registered by mail should not fill in another card, just obtain a badge. A separate registration will be conducted for the IRE meeting but IRE members are cordially invited to attend any AIEE sessions and AIEE members are likewise invited to attend IRE sessions. A registration fee of $2 will be charged all nonmembers except Enrolled Students, the immediate families of members, and those attending the IRE meetings. Hotel reservations should be made by writing directly to the hotel preferred.

COLUMBIA ENGINEERS' DINNER

The annual informal dinner for Columbia electrical engineers will be held Wednesday evening, January 27, at the Columbia University Club, 4 West 43d Street. A social half hour will precede the dinner, which is scheduled for 6:30 p.m.

COMMITTEE

The personnel of the committee making arrangements for the 1943 meeting is:

C. R. Jones, *chairman* (M '30), F. A. Cowan (M '29), W. S. Hill (M '30), M. D. Hooven (M '30), A. E. Knowlton (M '30), C. S. Purnell (M'35), R. L. Webb (M '35), C. C. Whipple (M '26).

Summarized Schedule of Principal Events

Monday, January 25

9:00 a.m.	Registration
9:30 a.m.	Capacitor generators and transformer loading
9:30 a.m.	Relaying
9:30 a.m.	Electrical machinery
2:00 p.m.	Transmission lines
2:00 p.m.	Conference on relays
2:00 p.m.	Conference on selection of motors and controllers
7:30 p.m.	Conference on emergency loading of transmission systems

Tuesday, January 26

9:30 a.m.	Transmission and distribution
9:30 a.m.	Land transportation
9:30 a.m.	Industrial power applications
2:00 p.m.	Relaying on long transmission lines
2:00 p.m.	Conference symposium on defense lighting
2:00 p.m.	Basic sciences
2:00 p.m.	Conference on emergency rating of power cables

Wednesday, January 27

10:00 a.m.	General session
2:00 p.m.	Conference on wartime engineering education
2:00 p.m.	Conference on getting the most out of electronic tubes in wartime
2:00 p.m.	Conference on substation designs to meet wartime conditions
8:15 p.m.	Medal presentations

Thursday, January 28

9:30 a.m.	IRE technical session
9:30 a.m.	Circuit breakers and switches
9:30 a.m.	Conference on power generating equipment
2:00 p.m.	IRE annual business meeting
2:00 p.m.	Switching equipment and related subjects
2:00 p.m.	Conference on industrial distribution
8:30 p.m.	AIEE–IRE meeting

Friday, January 29

9:30 a.m.	Transformer loading
9:30 a.m.	Radio measurements
9:30 a.m.	Conference on analysis of military loads and postwar application
2:00 p.m.	Transformer loading discussion
2:00 p.m.	Conference on basic characteristics of varistors

Future AIEE Meetings

National Technical Meeting
New York, N. Y., January 25–29, 1943

District Technical Meeting
Pittsfield, Mass., April 8–9, 1943

District Technical Meeting
Kansas City, Mo., April 28–30, 1943

National Technical Meeting
Cleveland, Ohio, June 21–25, 1943

Tentative National Technical Meeting Program

Monday, January 25

9:30 a.m. Capacitor Generators and Transformer Loading

43-13. Steady-State and Transient Stability Analysis of Series Capacitors in Long Transmission Lines. **J. W. Butler, J. E. Paul, T. W. Schroeder,** General Electric Company

43-8. Self-Excited Oscillations of Capacitor-Compensated Long-Distance Transmission Systems. **R. B. Bodine, C. Concordia, G. Kron,** General Electric Company

43-16. Mobile Capacitor Units for Emergency Loading of Transformers in Open Delta. **H. B. Wolf, G. G. Mattison,** Duke Power Company

43-25. Kilowatts, Kilovars, and System Investments. **J. W. Butler,** General Electric Company

43-45. Open-Delta Transformer Banks—Analysis of Circuit. **J. E. Clem,** General Electric Company

43-48. Shunt Capacitors. General systems subcommittee of the committee on power transmission and distribution.

9:30 a.m. Relaying

43-27. Pilot-Wire Circuits for Protective Relaying—Experience and Practice. Relay subcommittee, committee on protective devices

43-15. A New Generator Differential Relay. **A. J. McConnell,** General Electric Company

43-28. The Effect of Current-Transformer Residual Magnetism on Balanced-Current or Differential Relays. **H. T. Seeley,** General Electric Company

43-5. Correlation of System Overvoltages and System-Grounding Impedance. Working group on correlation of system-grounding impedance

9:30 a.m. Electrical Machinery

43-2. A Useful Equivalent Circuit for a Five-Winding Transformer. **L. C. Aicher, Jr.,** Allis-Chalmers Manufacturing Company

43-3. A New Type of Adjustable-Speed Drive for Alternating-Current Systems. **A. G. Conrad, S. T. Smith, P. F. Ordung,** Yale University

43-4. Performance Calculations on Tapped-Winding Capacitor Motors. **P. H. Trickey,** Diehl Manufacturing Company

43-6. Analysis of Rating Methods for Intermittent Loads. **R. E. Hellmund** (deceased) formerly with Westinghouse Electric and Manufacturing Company

43-47. Factors Affecting the Design of D-C Magnets. **L. T. Rader,** General Electric Company

2:00 p.m. Transmission Lines

43-7. Abnormal Overvoltages Caused by Transformer Magnetizing Currents in Long Transmission Lines. **H. A. Peterson, T. W. Schroeder,** General Electric Company

43-21. Wood-Pole 230-Kv Transmission Lines. **O. S. Clark,** United States War Department

43-29. Transmission-Line and System Problems in Supplying Large Electric Arc Furnaces During Wartime. **B. M. Jones,** Duquesne Light Company

43-22. Ampere Load Limits for Copper in Overload Lines. **A. H. Kidder, C. B. Woodward,** Philadelphia Electric Company

43-20. Intrasystem Transmission Losses. **E. E. George,** Ebasco Services, Inc.

2:00 p.m. Conference on Relays

Introduction: H. F. Lindemuth

CP.* Acceptance Tests and Installation Tests. **S. C. Leland,** Westinghouse Electric and Manufacturing Company

CP.* Calibration Tests. **J. C. Bowman,** Public Service Electric and Gas Company

CP.* Routine Tests, Inspection, and Trouble Checks. **C. A. Muller,** American Gas and Electric Service Corporation

CP.* Reports and summary. **J. H. Oliver,** General Electric Company

CP.* Report from the working group on war activities. **L. F. Kennedy,** General Electric Company

2:00 p.m. Conference on Selection of Motors and Controllers

43-62. Proposed Guide for the Selection of Electric Motors and Motor Controllers. Report of committee on electrical, machinery, committee on industrial power applications (Applies to American Standard C50, "Rotating Electrical Machinery," and AIEE Standard 15, "Industrial Control Apparatus")

The conference session will consist of a number of prepared discussions of conference papers on various aspects of the guide. There also will be opportunity for open discussion on the guide.

7:30 p.m. Conference on Emergency Loading of Transmission Systems

Tuesday, January 26

9:30 a.m. Transmission and Distribution

43-10. Dielectric Recovery Characteristics of Large Air Gaps. **G. D. McCann, J. J. Clark,** Westinghouse Electric and Manufacturing Company

43-12. Impulse and 60-Cycle Characteristics of Driven Grounds—III, Effect of Lead in Ground Installation. **P. L. Bellaschi, R. E. Armington,** Westinghouse Electric and Manufacturing Company

43-26. Harmonics and Load Balance of Multiphase Rectifiers—Considerations in the Selection of the Number of Rectifier Phases. **R. D. Evans,** Westinghouse Electric and Manufacturing Company

43-30. Pulling Loads on Single- and Multiple-Conductor Impregnated-Paper Lead-Encased Cable, Solid Type. **A. P. S. Bellis,** John A. Roebling's Sons Company

43-23. Electrical Stability of Electrical-Insulating Oils Under Limited Oxidation. **J. C. Balsbaugh, A. G. Assaf,** Massachusetts Institute of Technology

43-34. Metering Power on the Low-Voltage Side. **A. J. Petzinger, B. E. Lenehan,** Westinghouse Electric and Manufacturing Company

9:30 a.m. Land Transportation

CP.* The Sorocabana Railway Electrification. **Durval Muylaert,** Sorocabana Railway

CP*. Train Communication. **L. O. Grondahl, P. N. Bossart,** Union Switch and Signal Company

43-33. Keep Them Rolling. **J. W. Teker,** General Electric Company

43-49. Factor Involved in the Selection of Railroad Motive Power. **H. C. Wilcox, A. G. Oehler,** *Railway Age*

9:30 a.m. Industrial Power Applications

43-17. Paired-Phase Busbars for Large Polyphase Currents. **L. E. Fisher, R. L. Frank,** Bull Dog Electric Products Company

43-41. The Power-Recovery System of Testing Aircraft Engines. **G. E. Cassidy, W. A. Mosteller, W. L. Wright,** General Electric Company

43-31. Synchronous Motors With Controlled Excitation for Suddenly Applied Loads. **W. K. Boice, B. H. Caldwell, M. N. Halberg,** General Electric Company

2:00 p.m. Relaying on Long Transmission Lines

43-19. Switching Overvoltage Hazard Eliminated in High-Voltage Oil Circuit Breakers. **L. F. Hunt,** Southern California Edison Company, Ltd.; **E. W. Boehne, H. A. Peterson,** General Electric Company

43-37. Performance Requirements for Relays on Unusually Long Transmission Lines. **F. C. Poage, C. A. Streifus, D. M. MacGregor, E. E. George,** Ebasco Services, Inc.

43-38. Protective Relaying for Long Transmission Lines. **A. R. VanC. Warrington,** General Electric Company

43-39. Staged-Fault Tests of Relaying and Stability on Kansas–Nebraska 270-Mile 154-Kv Interconnection. **C. W. Minard, E. A. Swanson,** Nebraska Power Company; **R. B. Gow, W. A. Wolfe,** Kansas Gas and Electric Company

2:00 p.m. Conference Symposium on Defense Lighting

This is one of a series of conferences sponsored by the committee on production and application of light to present up-to-the-minute defense lighting activities and developments from both the military and civilian points of view.

Tom P. Walker, president of Council of Electric Operating Companies, Washington, D. C.

Richard E. Simpson, chairman, dimout counsulting committee, State Defense Council, Conn.

Lieutenant Colonel B. W. Beers, executive officer, Operating and Training Division, Headquarters Second Service Command, Governors Island, N. Y.;

● **PAMPHLET reproductions of authors' manuscripts of the numbered papers listed in the program may be obtained as noted in the following paragraphs.**

● **ABSTRACTS of most papers appear on pages 27–34 of this issue and pages 619–20 of the December 1942 issue.**

● **PRICES and instructions for procuring advance copies of these papers accompany the abstracts. Mail orders are advisable, particularly from out-of-town members, as an adequate supply of each paper at the meeting cannot be assured. Only numbered papers are available in pamphlet form.**

● **COUPON books in $5 denominations are available for those who may wish this convenient form of remittance.**

● **THE PAPERS regularly approved by the technical program committee ultimately will be published in "Transactions"; many will appear in "Electrical Engineering."**

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* CP: Conference paper; no advance copies are available; not intended for publication in *Transactions.*

Major **R. P. Breckenridge**, Corps of Engineers, Camouflage Branch, United States Army, Fort Belvoir, Va.

2:00 p.m. Basic Sciences

43-11. Formulas for the Calculation of the Inductance of Linear Conductors of Structural Shape. **T. J. Higgins**, Illinois Institute of Technology

43-50. Generation of Electric Charges by Moving Rubber-Tired Vehicles. **S. S. Mackeown**, California Institute of Technology; **Victor Wouk**, Westinghouse Electric and Manufacturing Company

43-43. Skin Effect in Bimetallic Conductors **B. R. Teare, Jr., Josephine R. Webb**, Carnegie Institute of Technology

43-9. Equivalent Circuits for Oscillating Systems and the Riemann-Christoffel Curvature Tensor. **Gabriel Kron**, General Electric Company

2:00 p.m. Conference on Emergency Rating of Power Cables

Wednesday, January 27

10:00 a.m. General Session

Presentation of Alfred Noble Prize to George W. Dunlap

Technical Man Power As an Aid to the War Effort

2:00 p.m. Conference on Wartime Engineering Education

CP.* Continuing Programs of Specialized Engineering Education for Military and Industrial Services, and the Allocation of the Technical Graduates. **Edward C. Elliott**, chief, professional and technical employment and training division, War Manpower Commission, and president, Purdue University

CP.* Accelerated Programs of Specialized Engineering Education Versus the Short Specialized Types of Training. **Henry T. Heald**, president, Society for the Promotion of Engineering Education, and president, Illinois Institute of Technology

CP.* The Increasing Need of Engineering Graduates in Industry During a Prolonged War Period. **Maynard M. Boring**, apparatus design engineering department, General Electric Company

Announcement: A meeting of the committee on education will directly follow this session.

2:00 p.m. Conference on Getting the Most Out of Electronic Tubes in Wartime

This conference will take the form of an informal discussion on methods of operating electronic devices to improve their life and increase their usefulness under existing wartime conditions. The question of adequate rating of electronic devices to permit the obtaining of their maximum utility will also be considered. Several speakers will introduce briefly these topics, after which discussion from the floor will be in order. It is hoped to obtain a wide participation by those present.

2:00 p.m. Conference on Substation Designs to Meet Wartime Conditions

Thursday, January 28

9:30 a.m. IRE Technical Session

9:30 a.m. Circuit Breakers and Switches

43-32. An Improved Axial Air-Blast Interrupter for Severe Operating Duty. **P. L. Taylor, H. W. Martin**, Allis-Chalmers Manufacturing Company

43-44. A New 50,000-Kva—5-Kv Oilless Circuit Breaker and Metal-Clad Switchgear Unit. **R. C. Dickinson, B. I. Hayford**, Westinghouse Electric and Manufacturing Company

43-51. A Vertical-Flow Compressed-Air Circuit Breaker and Its Application on a 132-Kv Power System. **H. A. P. Langstaff**, West Penn Power Company; **B. P. Baker**, Westinghouse Electric and Manufacturing Company

43-52. The Auto-Blast Interrupter Switch. **E. A. Williams, Jr., W. G. Harlow**, General Electric Company

43-53. A Multiorifice Interrupter for High-Voltage Oil Circuit Breakers. **L. R. Ludwig, W. M. Leeds**, Westinghouse Electric and Manufacturing Company

9:30 a.m. Conference on Power Generating Equipment

The objective of this conference is to correlate all possible ideas on how to get the most out of present equipment.

CP.* Emergency Measures to Increase Output of Generating Equipment. **C. M. Laffoon**, subcommittee chairman

CP.* Emergency Measures to Increase Output of Generating Systems. **R. P. Crippen**, subcommittee chairman

CP.* Wartime Personnel Problems

The first memorandum will contain case examples of the effect of voltage, ambient temperature, hydrogen pressure, and so forth, on the operation of turbine and waterwheel generators. The second memorandum is being prepared from answers to a questionnaire submitted to the leading operating companies together with summation on such subjects as loading limits on equipment, maintenance, power-factor correction, interconnected operation, effect of voltage and frequency on system loads, rebuilding or rehabilitation of equipment or stations, and so forth. The two memoranda are intended to serve as a basis for questions and discussions from the audience, to which the major part of the conference will be devoted.

2:00 p.m. IRE Annual Business Meeting

2:00 p.m. Switching Equipment and Related Subjects

43-54. Oil-Impregnated Paper High-Voltage Condenser Bushings for Circuit Breakers and Transformers. **H. J. Lingal, H. L. Cole, T. R. Watts**, Westinghouse Electric and Manufacturing Company

43-35. The Cathode-Ray Oscillograph Applied to Long-Time Switching Transients. **G. W. Dunlap, N. Rohats**, General Electric Company

43-63. Application of Lightning Protective Devices in Wartime. **I. W. Gross**, American Gas and Electric Service Corporation

43-55-ACO†. Preliminary Report on Guides for Application and Operation of Circuit Breakers and Switchgear. Subcommittee on circuit breakers, switches, and fuses, committee on protective devices.

2:00 p.m. Conference on Industrial Distribution

43-40-ACO.† A Proposed Wartime Guide for Industrial Power Distribution Systems. Interim report of committee on industrial power applications

8:30 p.m. IRE–AIEE Meeting

Address: "Ultrahigh Frequencies." **Doctor G. C. Southworth**, Bell Telephone Laboratories, Inc.

*CP: Conference paper; no advance copies are available; not intended for publication in *Transactions*.

†ACO: Advance copies only available; not intended for publication in *Transactions*.

Friday, January 29

9:30 a.m. Transformer Loading

43-56. Cooling Power Transformers by Forced Circulation of Cooling Medium. **K. K. Paluev, L. H. Burnham**, General Electric Company

43-18. Equivalent Ambient Temperatures for Loading Transformers. **W. C. Sealey**, Allis-Chalmers Manufacturing Company

43-36. The Rating of Power Transformers As Determined by the War Emergency. **R. J. Salsbury, A. F. Phillips**, Duquesne Light Company

43-24. Substation Transformer Emergency Overloading Practice. **L. W. Clark**, The Detroit Edison Company

9:30 a.m. Radio Measurements

43-14. An Electromechanical Calculator for Directional Antenna Patterns. **C. E. Smith**, United Broadcasting Company; **E. L. Gove**, North Hollywood, California

43-57. Measurements Pertaining to the Coordination of Radio Reception With Power Apparatus and Systems. **C. M. Foust, C. W. Frick**, General Electric Company

43-58. Effect of Radio Frequencies of a Power System on Radio-Receiving Systems. **C. V. Aggers, W. E. Pakala**, Westinghouse Electric and Manufacturing Company; **W. A. Stickel**, West Penn Power Company

43-1. An Instrument for the Determination of Contact Making and Breaking Time. **Walther Richter, W. H. Elliot**, Cutler-Hammer, Inc.

43-59. Insulation Testing of Electric Windings. **C. M. Foust, N. Rohats**, General Electric Company

9:30 a.m. Conference on Analysis of Military Loads and Postwar Application

43-60. Estimating Electric Loads for Military Training Bases, Federal Housing, and Other Wartime Projects. **H. M. Potts**, Bonneville Power Administration

H. P. Seelye and **D. K. Blake** will discuss the relationship of distribution to the general problem with emphasis on conservation possibilities

CP.* A Method of Analyzing Wartime Loads. **W. L. Tadlock**, The Commonwealth and Southern Corporation

CP.* Matters of Safety

1. To people; 2. In equipment design. **S. B. Williams**

R. B. Shepard will comment and **C. F. Scott** will discuss the relationship of ambient and operating temperatures to the problem of safety.

CP.* Wartime Electric Motors and Their Postwar Applications. **J. L. Hamilton**, Century Electric Company

43-61. Rural Electrification Engineering and Electroagricultural Engineering. **M. M. Samuels**, United States Department of Agriculture, Rural Electrification Administration

2:00 p.m. Transformer Loading Discussion

2:00 p.m. Conference on Basic Characteristics of Varistors

This résumé will cover various nonohmic devices, nonsymmetrical, such as copperoxide and other rectifier types, as well as the symmetrical, including the more recently developed thermistor types. It should be of considerable interest to all engineers. Authoritative speakers will initiate the discussion by presenting up-to-date information on the various types, such as their current voltage relationships, temperature and humidity effects, maximum voltage or power limitations, polarization and frequency effects, and minimum useful voltage.

AIEE Nominating Committee for 1942–43 Announced

The national nominating committee of the AIEE, in accordance with the Institute's bylaws, will meet during the national technical meeting to be held January 25–29, 1943, in New York, N. Y., to nominate national officers to be voted upon by the membership in the spring of 1943. Members of the national nominating committee are as follows:

Representing the board of directors

M. S. Coover, Iowa State College, Ames, Iowa.

Mark Eldredge, 2110 Spencer Road, Silver Spring, Md.

C. R. Jones, Westinghouse Electric and Manufacturing Company, New York, N. Y.

T. G. LeClair, Commonwealth Edison Company, Chicago, Ill.

E. T. Mahood, Southwestern Bell Telephone Company, Kansas City, Mo.

Representing the Ten Geographical Districts

1. A. G. Conrad, Yale Station DLE, New Haven, Conn.

2. B. Van Ness, Jr., Pennsylvania Water and Power Company, Baltimore, Md.

3. C. C. Whipple, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

4. Stanley Warth, Southern Bell Telephone and Telegraph Company, Jacksonville, Fla.

5. E. B. Paine, University of Illinois, Urbana, Ill.

6. Hubert Sharp, The Mountain States Telephone and Telegraph Company, Denver, Colo.

7. V. P. Hessler, University of Kansas, Lawrence.

8. Willis T. Johnson, California Electric Power Company, El Centro, Calif.

9. A. LeRoy Taylor, University of Utah, Salt Lake City.

10. C. A. Price, Canadian Westinghouse Company, Ltd., Hamilton, Ont.

Alternates:

4. J. P. Argo, 1478 Snowden Avenue, Memphis, Tenn.

5. J. A. Northcott, Jr., University of Notre Dame, Notre Dame, Ind.

6. H. B. Palmer, University of Colorado, Boulder, Colo.

8. Franklin F. Evenson, P. O. Box 1710, San Diego, Calif.

10. A. H. Frampton, Hydro-Electric Power Commission of Ontario, Toronto, Ont.

Contents of December 1942 Supplement

Technical papers to supplement those published in the monthly Transactions sections of *Electrical Engineering* for July through December will appear in the December 1942 "Supplement to Electrical Engineering—Transactions Section." This supplement will contain seven papers, their discussions, and the discussions of technical papers published in the July—December monthly sections. The publication of this supplement completes the publication of papers and discussions presented at the 1942 AIEE North Eastern District meeting in Schenectady, N. Y., the 1942 AIEE summer convention in Chicago, Ill., and the 1942 AIEE Pacific Coast convention in Vancouver, B. C., Canada.

Copies of the supplement will be mailed shortly to those who entered advance orders. Other may obtain copies at 50 cents each from the AIEE order department, 33 West 39th Street, New York, N. Y., as long as the limited supply lasts.

Papers appearing in the December 1942 supplement, abstracts of which have been published in *Electrical Engineering* in advance of the Chicago and Vancouver conventions, are:

42-145—The Combination of Probability Curves in Engineering; *Roger I. Wilkinson (A '35).* Abstracted in July 1942 issue, page 362.

42-115—Emergency Overloading of Air-Cooled Oil-Immersed Power Transformers by Hot-Spot Temperatures; *V. M. Montsinger (F '29), P. M. Ketchum (A '39).* Abstracted in June 1942 issue, page 324.

42-112—Series Capacitors for Transmission Circuits; *E. C. Starr (F '41), R. D. Evans (F '40).* Abstracted in June 1942 issue, page 326.

42-103—Induced Voltages on Transmission Lines; *C. F. Wagner (F '40), G. D. McCann (A '38).* Abstracted in May 1942 issue, page 262.

42-111—Load Ratings of Cable—II; *Herman Halperin (M '26).* Abstracted in June 1942 issue, page 326.

42-117—Stability Study of A-C Power-Transmission Systems—I and II; *John Grzybowski Holm (M '29).* Abstracted in June 1942 issue, page 326.

42-90—Factors Which Influence the Behavior of Directional Relays; *T. D. Graybeal (A '38).* Abstracted in May 1942 issue, page 262.

Edwin Armstrong Awarded 1942 Edison Medal

Edwin Howard Armstrong, professor of electrical engineering at Columbia University, New York, N. Y., has been named the recipient of the Edison Medal, highest AIEE award, for the year 1942, "for distinguished contribution to the art of electric communication, notably the regenerative circuit, the superheterodyne, and frequency modulation." Presentation of the medal will take place at the AIEE national technical meeting, January 25–29, 1943.

Major Armstrong was born in New York, N. Y., on December 18, 1890, and received the degrees of electrical engineer in 1913 and doctor of science in 1929 from Columbia University. He was a protégé of Michael I. Pupin, past president of the AIEE and recipient of the Edison Medal in 1920, and worked closely with him on a number of research projects.

Major Armstrong's research on the operating properties of the audion detector resulted in his invention of the feedback or regenerative circuit which became the means not only of increasing the sensitivity of the audion as a detector of radio signals but also became the means of producing for the first time continuous high-frequency oscillations by means of a thermionic tube.

While serving in the United States Army in France during World War I, he made his second invention, the superheterodyne receiving system, which was destined to be another cornerstone in the development of the radio communication art. This system of receiving far surpassed any development up to that time and it is still the type of circuit used today in many radio receivers.

In 1922 came his development of the superregenerative circuit, a system of radio reception providing a means of increasing the sensitivity of a detector above that normally obtained. This receiving circuit supplied the principal means of exploring and developing the ultrashort-wave channels. In 1933 his development of wide-band frequency modulation was disclosed. This system is now recognized as the basis for an entirely new era in radiobroadcasting and communication.

Major Armstrong served as associate professor of research at Columbia University from 1914 to 1935, when he became professor of electrical engineering.

Among the honors received by Major Armstrong are the following: Medal of Honor of the Institute of Radio Engineers in 1917 for his work in developing regeneration; Chevalier de la Legion d'Honneur of the French Government in 1919; Eggleston Medal in 1939 at Columbia University; the Holley Medal of the American Society of Mechanical Engineers for 1940; the Franklin Medal of the Franklin Institute for 1941; and the John Scott Medal for 1942, awarded by the board of directors of City Trusts, Philadelphia, Pa.

ABSTRACTS . . .

TECHNICAL PAPERS previewed in this section will be presented at the AIEE national technical meeting, New York, N. Y., January 25–29, 1943, and are expected to be ready for distribution in advance pamphlet form within the current month. Copies may be obtained by mail from the AIEE order department, 33 West 39th Street, New York, N. Y., at prices indicated with the abstract; or at five cents less per copy if purchased at AIEE headquarters or at the convention registration desk.

Mail orders will be filled AS PAMPHLETS BECOME AVAILABLE

Basic Sciences

43-23—Electrical Stability of Electrical Insulating Oils Under Limited Oxidation; *J. C. Balsbaugh (M '35), A. B. Assaf. 30 cents.* Under limited oxidation copper and lead produce electrical instability with power factor nearly proportional to metal area. Copper may produce very high losses without significant change in color, indicating copper compound formed in the cuprous state. Also, paper generally has negligible effect on electrical characteristics; products responsible for loss are not adsorbed by paper. In continuous oxidation, paper readily adsorbs oxidation products of acids and water. Copper–oil ratios, important in operating performance of oil–paper cables, indicate relatively high values for certain limiting conditions difficult to reproduce in satisfactory test cell. Small percentage of aromatics generally gives more stable oil and may be also a function of copper–oil ratio and of the amount of available oxygen. Oils with different physical characteristics show wide differences in electrical characteristics;

straight hydrocarbons are somewhat the same as commercial insulating oils. It is believed that the type of hydrocarbon plays some part, though nonhydrocarbon components determine the characteristics to a large extent. Limited-oxidation characteristics of oils change on standing in container. Over-refined oils generally give electrical stability in initial period of continuous oxidation but finally produce large amounts of water and low-molecular-weight acids.

43-43—Skin Effect in Bimetallic Conductors; *B. R. Teare, Jr.* (*F'42*), *Josephine R. Webb* (*A'41*). *20 cents.* A knowledge of the behavior of bimetallic conductors at frequencies up to 150 kilocycles has become important for the designing of carrier-current communication systems. General equations are derived for bimetallic conductors with circular symmetry, giving the a-c distribution and the impedance per-unit length. The results are illustrated by applying them to a copper-covered steel conductor. Measurements of the a-c resistance in the same frequency range provide a check on the theoretical results. The studies made on the copper-covered steel conductor indicate that for all but the lowest frequencies its resistance is substantially that of the tubular copper portion alone and may be taken from the simpler formulas and curves already available for tubes.

43-50—Generation of Electric Charges by Moving Rubber-Tired Vehicles; *S. S. Mackeown* (*M'34*), *Victor Wouk* (*Enrolled Student*). *15 cents.* The current flowing to ground from an automobile whose rear wheels were turning on a dynamotor was measured. The magnitude of the constant current measured shows that the car is electrically charged by conduction through the tires. The experimental results are consistent with the conception of a simple equivalent electric circuit. Approximate values of the elements of this equivalent circuit were obtained. Constant current as high as four microamperes was measured from a car grounded through a meter when the two rear wheels were driven at a speed of 40 miles per hour on the dynamotor. These results were checked by road tests. Calculation shows that the tires are sufficiently conducting to discharge the car in a short time after the car is stopped.

Communication

43-14—An Electromechanical Calculator for Directional-Antenna Patterns; *Carl E. Smith* (*M'38*), *Edward L. Gove* (*M'35*). *15 cents.* An electromechanical calculator has been designed for the rapid solution of directional-antenna patterns. The machine automatically draws the field-intensity curves to any desired scale on polar coordinate paper and indicates the rms value for drawing a circle of the equivalent nondirectional pattern. The fundamental design of the calculator does not limit the number of antennas. Not only is the horizontal directional field-intensity pattern, such as used in broadcast practice, readily available but the field-intensity curves at any elevation angle can be drawn with equal ease. The vertical-radiation characteristics of the several antennas can be selected at will. This makes it possible to explore the solid-contour surface of the whole hemisphere in a relatively short time and also to determine the total power radiated from the system. In addition, the calculator is useful for determining the solid-contour surface of parallel horizontal antenna systems.

43-58—Effect of Radio Frequencies of a Power System on Radio-Receiving Systems; *C. V. Aggers* (*A'39*), *W. E. Pakala* (*A'38*), *W. A. Stickel*. *15 cents.* This paper describes tests and gives results of radio-frequency measurements to determine the correlation between radio-frequency voltages and fields of power lines and the effects of these on the radio-listener's antenna. These results are useful in the approximate determination of the influence on radio-receiving systems of radio-frequency voltages sometimes produced incidental to the operation of a power system.

Domestic and Commercial Application

43-61—Rural Electrification Engineering and Electroagricultural Engineering; *M. M. Samuels* (*F'24*). *15 cents.* A survey is presented of developments in the fields of rural electrification and electroagricultural engineering since their beginnings. The paper discusses rural distribution lines, telephone co-ordination, voltage regulation, ground testing of rural circuits, electrical soil treatment, the problems of water supply and home lighting, electric equipment on the farms, and other similar subjects. Possible developments in these fields after the war and directions in which progress will be made are considered at some length.

Electrical Machinery

43-16—Mobile Capacitor Units for Emergency Loading of Transformers in Open Delta; *Herman B. Wolf* (*M'37*), *G. G. Mattison* (*A'41*). *15 cents.* Present conditions necessitate full-load operation of substation transformers; therefore, as the number of loaded substations increases, the problem of maintaining service upon the failure of one transformer in a delta-delta bank becomes more serious, for the supply of emergency replacement transformers is limited. Moreover, the time required to move and install replacement transformers results in a comparatively long curtailment of load or interruption to service. One solution to this problem utilizes mobile capacitor units with capacitance arranged for correcting the unbalance in voltage and current resulting from open delta operation and at the same time reducing the transformer loading to within the range of forced air cooling. The mobile unit may be towed by a car or light truck and is applicable to loads up to 1,200 kva or more, depending on the power factor, two or more mobile units being applied to larger loads. Simplicity of connection and high mobility permit rapid installation.

43-18—Equivalent Ambient Temperatures for Loading Transformers; *W. C. Sealey* (*M'38*). *15 cents.* Safe overloads for transformers can be determined by a modification of the American Standards Association rule for overloading, to permit the use of an equivalent ambient temperature which will result in the same loss of life as for continuous operation at 30 degrees centigrade ambient and full load. Based on relations governing aging of insulation, methods are developed for calculating the equivalent ambient temperature based on weather-bureau records. The equivalent ambient temperature for each month is calculated as the sum of the greatest recorded monthly mean temperature, plus a daily correction factor based on the greatest recorded daily range, plus a monthly correction factor based on the greatest recorded monthly range. Monthly equivalent ambient temperatures so obtained can be used in combination with load curves to determine the permissible safe load for a transformer for a given locality.

43-24—Substation-Transformer Emergency Overloading Practice; *L. W. Clark* (*M'25*). *20 cents.* The allowable emergency overload capacity of any transformer can be matched quickly and accurately with the overload to be carried taking full account of the individual transformer characteristics and the specific shape of the overload curve. The method of reaching a common basis for ready comparison consists of

1. Determining the allowable 24-hour steady load that can be carried on the transformer without exceeding certain agreed-upon limits.

2. Converting the specific load curve to a 24-hour steady load which would cause equivalent aging of the transformer insulation.

Nomographs are included for quick determination of allowable transformer 24-hour overloads, taking into account ambient temperature, top-oil rise, average copper rise, and ratio of copper to core loss. Empirical multipliers are also given which facilitate the conversion of the load curve to equivalent 24-hour steady load in no more time than it would take to calculate load factor.

43-31—Synchronous Motors With Controlled Excitation for Suddenly Applied Loads; *W. K. Boice* (*A'39*), *B. H. Caldwell* (*A'37*), *M. N. Halberg* (*A'29*). *25 cents.* This paper shows the advantages of automatic control of the field current of syn-

chronous motors applied to varying loads. These include higher operating efficiency and better power-system voltage regulation. Furthermore, for certain types of load, the use of automatic field control, properly co-ordinated with the motor design, will permit substantial saving of critical materials. The use of automatic field control is not limited to applications in which load changes occur gradually. The paper shows that in many cases such control is entirely practical even where high peak loads are suddenly applied. The method of analysis developed can be used to determine the performance of any synchronous motor with various excitation systems and load changes. Curves are included which show the maximum suddenly applied load that can be carried with a variety of motor and excitation system characteristics. The calculations are confirmed by load tests on a 2,100-horsepower motor.

43-36—The Rating of Power Transformers as Determined by the War Emergency; *R. J. Salsbury* (*M '34*), *A. F. Phillips* (*A '32*). *25 cents.* During the war it is desirable to base station ratings on the recurrent capacitance of all the transformer banks available for service rather than attempt to set up abnormally high emergency ratings based on the failure of one unit. If a maximum utilization of the total transformer capacitance is to be realized, it is essential that each transformer bank be calculated individually, since the thermal ratings of units of the same size vary widely. A method is discussed of systematically increasing transformer ratings as the station load grows, whereby the amount of detailed calculations and supervision of the loads are reduced to a minimum. Four steps are used in this method: the first step considers the ambient temperature; the second step, the manufacturer's test data and operating conditions; the third step, the thermal capacity, and the fourth step, the length of time at each hot-spot temperature. This last step, which is called the equal-life method of rating, takes into consideration the variations in daily peak loads, the variation in ambient temperatures, and the hot-spot temperature cycle. Each successive step which usually results in a higher rating utilizes the data obtained from the previous method. Several words of caution with respect to rating transformers are mentioned, and methods of handling emergencies are briefly discussed.

43-47—Factors Affecting the Design of D-C Magnets; *L. T. Rader* (*A '34*). *15 cents.* This paper outlines some of the factors which should be considered in the design of d-c magnets. The usual types of steel used are discussed briefly, including their influence of pole-face area on the force developed by the magnet. Flux measurements on a number of magnets show that theoretical calculations are often in great error because of factors such as leakage and saturation which are usually neglected. Data show that the flux in a d-c magnet with a small air gap may vary by as much as 300 per cent between one part of the circuit and another.

43-56—Cooling Power Transformers by Forced Circulation of Cooling Medium; *K. K. Paluev* (*M '29*), *L. H. Burnham* (*A '07*). *25 cents.* The paper discusses the various methods that have been used in cooling power transformers by forced circulation of the cooling medium, and points out the benefits:

1. To the war effort in the saving of critical materials.

2. To the user in first cost, shipment, installation station layout, and mobility.

The selection of proper control equipment is analyzed from the standpoint of protection and reliability of forced cooling. The relation between hot-spot and average winding temperatures and the future for forced cooling after the war are discussed.

43-62—Proposed Guide for the Selection of Electric Motors and Motor Controllers; *AIEE committee on electrical machinery and industrial power applications. 15 cents.* (Applies to American Standard *C*50, "Rotating Electrical Machinery," and AIEE Standard 15, "Industrial Control Apparatus.") The proposed guide explains briefly the necessity for conserving critical materials. It includes recommendations for selecting the size of electric motors, the type of electric motors, the size of motor controllers, and the type of motor controllers. Recommendations for selecting the size of electric motors include:

1. An accurate determination of the load requirements.

2. Factors to be used in determining the motor size on the basis of the load requirement and the type of motor required.

Recommendations for selecting the size of motor controller are based on the motor size with which it is to be used. Recommendations for selecting the type of motor and motor controller indicate simplifications which may be made in selection that result in savings of critical material. In the case of motors, the relative quantity of materials required for various types is indicated.

Industrial Power Applications

43-17—Paired-Phase Bus Bars for Large Polyphase Currents; *L. E. Fisher* (*M '38*), *R. L. Frank* (*A '40*). *15 cents.* The design of efficient conductors for large alternating currents has always been a problem, and the problem is especially difficult with large low-voltage, polyphase currents such as are found in enclosed bus-bar distribution systems for industrial plants. A new paired-phase method of arranging bus bars is described, which has excellent temperature rise, voltage drop, energy loss, and structural characteristics, for polyphase currents in the range of 1,000 amperes and above at 600 volts and less. The emphasis of the paper, however, is upon general characteristics of the paired-phase arrangement rather than the particular application to enclosed bus-bar systems. Comparative tests upon conventional laminated and interlaced arrangements and upon the paired-phase arrangement are presented, and the effect of varying dimensions is discussed. In addition to temperature-rise, voltage-drop, and energy-loss measurement, the current-density within the bus bars was studied by means of exploring wires, and the paired-phase arrangement is shown to be characterized by a peculiar current distribution which forms the basis for an explanation of its properties. A simple mathematical theory is developed to explain further the properties of the arrangement and to permit their calculation. Descriptive and performance data upon a variety of sizes of commercial paired-phase bus way are included.

43-40-ACO*—A Proposed Wartime Guide for Industrial-Power-Distribution Systems; *AIEE committee on industrial power applications. 70 cents.* The purposes of this proposed guide are to promote the use of sound engineering principles in the design and selection of industrial distribution systems and thereby conserve critical materials, and, in addition, to outline suggestions for the war period for the selection and application of apparatus and materials for use in these systems in order to promote further the saving of critical materials. The guide is divided into four sections. The first section will treat the broad subject of system planning. The second section deals with the problems involved in connection with the primary switching feeders of the usual industrial distribution systems. The third treats problems involved in connection with the transformation and low-voltage feeder protection. The fourth section covers the problems involved in the low-voltage distribution feeders, panelboards, bus distribution equipment, and load circuits. The guide applies to the following Standards: American Standards *C*57.1, *C*57.2, *C*57.3; AIEE Standard 19; American Standards *C*37.4, *C*37.5, *C*37.6, *C*37.7, *C*37.8, *C*37.9; AIEE Standards 20, 22, 23, 27, 27*A*, 28, 30, 33; AIEE reports 21, 25, 31.

43-41—The Power-Recovery System of Testing Aircraft Engines; *G. E. Cassidy* (*application pending*), *W. A. Mosteller, W. L. Wright. 20 cents.* Aircraft engines must be tested and broken in by operation under load for considerable periods of time before they are shipped from an aircraft-engine manufacturing plant. Several techniques are in vogue for accomplishing this testing, none of which utilizes the power output of the engines in test except a recently adopted electrical system of testing that has come to be referred to as the power-recovery system of testing aircraft engines. The paper describes the development of this electrical system and the part which it is playing in the testing of the large aircraft engines being built today. Data obtained from engine plants operating under the

*ACO—Advance copies only available; not intended for publication in AIEE *Transactions*.

electrical system are included to illustrate the advantages of the electrical system over other systems of testing aircraft engines.

Instruments and Measurements

43-35—The Cathode-Ray Oscillograph Applied to Long-Time Switching Transients; *G. W. Dunlap* (*M '42,*) *N. Rohats* (*A '36*). *15 cents.* The cathode-ray oscillograph, because of its inherent characteristics, is ideally suited and extensively used for the measurement of transient voltages associated with switching operations. The type of oscillograph ordinarily used covers a wide range of measurement conditions and is necessarily large and expensive. For this reason very few such units are available, and new problems, arising from the necessity of providing reliable service with loads increasing because of the war effort, have required every available measurement facility. In two recent applications, where extremely wide-range performance was not required, a two-tube low-voltage cathode-ray oscillograph was used successfully. This oscillograph and the two applications are described, and it is shown how such measurements of long-time transients may be made with portable, inexpensive, and relatively simple equipment embodying the advantages of cathode-ray oscillography.

43-57—Measurements Pertaining to Co-ordination of Radio Reception With Power Apparatus and Systems; *C. M. Foust* (*M '31*), *C. W. Frick* (*A '19*). *30 cents.* An adequate and practical co-ordination between power circuits and radio receivers is necessary to the end that each may provide effective service in its own field. Progress in achieving this co-ordination has been realized as rapidly as pertinent measurements have become obtainable. What to measure and how to measure it has been the basic problem. This paper deals with several outstanding aspects of the co-ordination problem, particularly from the measurement point of view.

1. Radio-noise meter calibrations.
2. Relation of apparatus noise levels to radio-receiver interference.
3. Radio-influence voltage for apparatus.
4. Radio-influence voltage variables in apparatus testing.

Under these headings data and interpretations are presented showing the performance fidelity of available noise meters, a series of ratios through which apparatus-influence voltages can be related to radio-receiver noise, considered limits of radio-influence voltages for apparatus, recommended test voltages, and several factors critical to influence voltage levels in apparatus.

43-59—Insulation Testing of Electric Windings; *C. M. Foust* (*M '31*), *N. Rohats* (*A '36*). *15 cents.* A description is given of a new winding-insulation testing equipment and method designed to provide adequate turn-to-turn and conductor-to-ground test-voltage stresses. Thus the tester fulfills the essential requirements for adequate dielectric testing of equipment on the production line and gives a definite indication when any defect arises. The voltage applied is designed to represent, with suitable safety margins, the kind of voltage stresses prevailing in service. The new winding-insulation testing equipment is made up of a repeating-type surge generator, a synchronized cathode-ray oscillograph, and suitable motor-driven and manual switching equipment. The repeating-type surge generator provides a succession of testing voltage waves controllable in shape and adjustable to provide the necessary turn-to-turn and conductor-to-ground stresses. The cathode-ray oscillograph is automatically timed to give a stationary image of the wave. A novel switching equipment and oscillograph-deflection connection controls the application of the voltage surges and so indicates wave shapes that insulation imperfections or winding dissymmetries are definitely revealed.

Land Transportation

43-33—Keep Them Rolling; *J. W. Teker* (*A '31*). *20 cents.* Preventive maintenance methods applied to electric and Diesel-electric locomotives now so essential to wartime transportation will keep locomotives on the road, ease the burden on repair shops, and conserve time, material and labor. A review of the fundamentals underlying common maintenance functions, such as apply to the lubrication of sleeve bearings, antifriction bearings, and gearing; the distinction between cog wheels and gearing with its relation to motor life, and a consideration of the far-reaching effects of operational abuses from a basic viewpoint, should stimulate responsible engineers and operators to examine and test their methods in this light. There is much that can be done while the locomotives are over the service pit during layovers in detection of impending trouble and in applying corrective measures. Failures do not happen—they are caused, and the analysis of events leading to them is necessary before the efforts of available manpower and facilities can be directed, not only in making repairs but in the application of preventive measures.

43-49—Factors Involved in the Selection of Railroad Motive Power; *H. C. Wilcox, A. G. Oehler* (*F '26*). *20 cents.* The paper presents the position of the three types of motive power in railroad service and offers a brief historical background to show how each one arrived at its present status. A table lists advantages and disadvantages inherent in each type and includes supplementary information to explain the listings in the table. The subject is presented from the viewpoint of the user, and a method of determining more closely the place for each type of locomotive is suggested. An appendix lists all of the considerations which must be included in a complete cost study.

Power Transmission, Distribution

43-12—Impulse and 60-Cycle Characteristics of Driven Grounds, III—Effect of Lead in Ground Installation; *P. L. Bellaschi* (*F '40*), *R. E. Armington* (*A '42*). *20 cents.* This paper, the third of a series, presents the impulse characteristics of leads and grounds. Typical down-leads and tower structures in combination with common shallow and deep-driven grounds, parallel grounds, and counterpoise grounds are studied. The inductance, resistance, capacitance, mutual effects, and time constants of the leads and grounds are determined and their relative importance discussed. From this, the analysis and calculations are simplified. In like manner ground installations comprising multiple paths to earth are amenable to simplified treatment. The terminal conditions in the earth and their importance are also surveyed. Comparative results are presented in curves which give the voltages and their form in ground installations for currents corresponding to lightning conditions. The impulse voltages developed are compared to the insulation characteristics of the installation (station and line apparatus, or object protected) and the problem of grounds assessed in relation to the protection and co-ordination of insulation.

43-13—Steady-State and Transient-Stability Analysis of Series Capacitors in Long Transmission Lines; *J. W. Butler* (*M '38*), *J. E. Paul* (*A '39*), *T. W. Schroeder* (*A '37*). *15 cents.* This paper presents the results of an analysis made to determine basic performance data of compensated lines under steady-state and transient conditions. Such performance data are fundamentally necessary for a complete analysis to determine where reactance compensation is economically applicable. Certain general conclusions can be drawn immediately, based on the performance data and a consideration of present-day good operating practice. The studies reported were made with the aid of the network analyzer, steady-state power limits and transient data for a receiving-end stub-feeder fault being obtained for lines 150, 300, and 450 miles long. Transient power limits were found for two parallel 300-mile lines with a high-voltage sending-end fault resulting in the switching out of a line section as a function of sending-end generator and receiver system capacity. In addition to showing the effect of various degrees of reactance compensation and number of switching stations, all studies evaluate the effect of transmission voltage, generator inertia, transient reactance, and short-circuit ratio. Illustrations are given indicating how the data presented may be used to find the effect of various combinations of these factors, so they may be used to an economically optimum degree.

43-20—Intrasystem Transmission Losses; *E. E. George* (*F '36*). *30 cents.* This paper

describes a new method of calculating transmission losses within power systems. The method is based on the principle of superimposing the load distribution from each source, determining the current in each line as a sum of the individual load flows (with each in its proper direction), squaring this expression for current, and setting up an equation for losses in terms of megawatt generation at the various plants and of megawatt flows (in or out) at each interchange point. The procedure consists chiefly in deriving a special loss formula for a given power system. The formula is suitable for any condition of generation, load, and interchange. The loss formula may be used for determination of losses, either total or incremental; for billing, forecasting, or system planning purposes. It has been used by several power companies for hour-by-hour determination of incremental losses. Other companies have used the formula to derive a typical or average per cent loss, subject to review monthly, or less often if operating conditions are reasonably uniform. Results check well with a-c calculating-board studies and with longhand calculations of intrasystem losses.

43-21—Wood-Pole 230-Kv Transmission Lines; *O. S. Clark (M '41). 15 cents.* This paper reports design conclusions reached and construction methods employed in the building of a 230-kv transmission line entirely of wood. Such construction has become necessary because of wartime restrictions on the use of steel. The design problem is not, fundamentally, a new one. Stresses involved, foundation requirements, and dimensions of structural members necessary to maintain separations between conductors and ground clearances present problems not encountered in the design of wood-pole transmission lines for lower voltages. In the interest of economy, braced crossarm members were used, which in turn made necessary complete transverse structural rigidity. The insulating value of wood was utilized in the design to obtain high impulse strength.

43-22—Ampere Load Limits for Copper in Overhead Lines; *A. H. Kidder (M '39), C. B. Woodward. 15 cents.* The paper deals with the carrying capacity of conductors in overhead lines, as determined by the effect of temperature and time upon the physical characteristics of the conductor. The paper does not deal with considerations of voltage variation, power loss, nor other factors that may favor larger conductors than are adequate physically for the immediate purpose. The paper presents a method for determining approximately the maximum continuous current-carrying capacity of conductors in overhead lines, as fixed by certain operating limits of temperature and time, beyond which it is expected that the physical characteristics of copper conductors might be materially impaired. The paper deals illustratively with conditions in the Philadelphia area, but the method is equally adaptable to any situation. The design limits of ampere ratings are from 10 to 35 per cent higher for bare conductors and from 10 to 20 per cent higher for covered conductors, than those previously used in the Philadelphia area. Operation at load equal to the design limit will, during 99.93 per cent of the hours in the average year, maintain copper temperatures below 100 degrees centigrade in normal operations and below 135 degrees centigrade in emergency operations.

43-25—Kilowatts, Kilovars, and System Investments; *J. W. Butler (M '38). 15 cents.* What portion of the total system investment can one equitably allocate to the system kilovar requirements? A rational answer is given to this question, and it is shown that the kilovar requirements of a system in general should be divorced from the kilowatt requirements and that the two factors should be dealt with as independent commodities, if maximum usage of system capacity is to be made in producing kilowatts. It is shown that a value of two to six per cent of the system investment is chargeable to the kilovar requirement when it is supplied near the load by auxiliary kilovar generators, as contrasted to 20 to 25 per cent when supplied by kilowatt generators in the power stations, for systems operating around 80 per cent power factor. The possible effects of establishing rates for kilovars based on the cost of supplying them by kilowatt generators are discussed. It is shown that this procedure, in providing an excessive inducement for the consumer to generate his own kilovars, results in the important system design and operating factor of kvar control tending to pass out of the hands of the operating company into the hands of the consumer.

43-30—Pulling Loads on Single- and Multiple-Conductor Impregnated-Paper Lead-Encased Cable Solid Type; *A. P. S. Bellis (A '26). 30 cents.* The pulling of lead-encased cable in underground systems by means of pulling grips or the like is an old art. Engineering consideration of the problem has failed to develop simple adequate rules for field use because of a lack of factual information as to what might be expected of the cable. It has been considered generally that no harm to the cable has resulted if visual evidence is not apparent on the outside of the sheath. The results of the investigation reported show evidence of disturbance of the mechanical uniformity of the insulation that is not detectable from an examination of the lead sheath. Certain factors in the problem have been evaluated, a field formula is offered, and a method of judging the possibility of damage to the cable through stretching the cable sheath excessively is suggested. It is hoped this work will stimulate renewed effort toward reduction of joint and cable failures within and adjacent to manholes.

43-26—Harmonics and Load Balance of Multiphase Rectifiers—Considerations in the Selection of the Number of Rectifier Phases; *R. D. Evans (F '40). 15 cents.* This paper analyzes the operating characteristics of multiphase power rectifiers from the standpoint of harmonics, load balance and their interrelation, and their effects on the apparatus and circuits to which they may be connected. These factors are considered in connection with selection of the number of rectifier phases, which varies from six (four for very small sizes) to combinations of six-phase units to form a much larger number, such as 36, 72, or even 108 phases. More specifically, the problems of harmonics, load balance, and number of phases are considered from the standpoint of the effects on

1. Apparatus, particularly turbine generators and capacitors.

2. The wave-shape distortion on circuits that may be important in inductive co-ordination.

3. The possibility of resonance being encountered in the supply system to amplify one or more of the rectifier harmonics.

These problems have increased greatly because of the great number and large size of rectifier installations made in connection with the war.

43-34—Metering Power on the Low-Voltage Side; *A. J. Petzinger (A '36), B. E. Lenehan (A '24). 20 cents.* Consumers of energy are often supplied from the high-voltage distribution or subtransmission circuits through stepdown transformer banks. When the consumers are to be charged on the basis of primary or high-voltage energy supply, some way is desirable of including the transformer losses, without necessitating the expense and difficulty of metering directly on the primary side. This paper presents a résumé of the various methods which may be considered. These methods may be classified broadly in four general groups. There is no "best method" for all installations, but each installation must be considered individually, including such factors as expense, customer relations, public-service commission requirements, and size of installation.

43-29—Transmission-Line and System Problems in Supplying Large Electric-Arc Furnaces During Wartime; *B. M. Jones (F '42). 20 cents.* Transmission extensions are made for large electric furnaces, using the minimum of copper, and are designed to prevent an adverse effect on the system, particularly the lighting. Voltage flicker limits are made more liberal, and in many cases rampant furnace operation is permitted. The ten cases cited cover 20 electric-arc furnace installations varying in size from 1,500 kva to 15,000 kva in ten plants. Radical changes are developed by rearranging the transmission network, splitting it apart at various locations, isolating existing lines for exclusive furnace use, and adding extensions to these exclusive lines and to the network itself. A considerable amount of copper is saved—in one instance, 53,000 pounds are saved by reducing the requirements from 64,000 to 11,000 pounds, and in another instance no line copper at all is used, because of rearranging the consumer's high-voltage bus to isolate an exclusive line for the furnace.

43-45—Open-Delta Transformer Bank—Analysis of Circuit; *J. E. Clem* (*F '38*). *20 cents.* In this paper it is shown that induction motors operated from an open-delta transformer bank may have additional losses when operating at full load, ranging from 33 to 93 per cent of the full load losses. Under some conditions this may result in serious overheating. A new method of determining the regulation of an open-delta transformer bank is offered, in which the negative-sequence current, as well as the positive-sequence current, is considered. This new method gives correct results and may be applied whether the load in the secondary circuit is balanced or unbalanced. Also there is given a new formula for the calculation of regulation by means of which the results may be obtained to any degree of precision justified by the supporting data. Charts are supplied by means of which the correct amount of capacitance to be added to balance the secondary voltages on open-delta operation may be estimated, and an illustrated example is worked out. An example illustrating the application of the new formulas for regulation is included. In addition, a chart is given outlining a new simplified method of determining the line-to-neutral voltages from the unbalanced line-to-line voltages. Also there is included in the chart a new and more direct method of finding the positive- and negative-sequence components.

43-48—Shunt Capacitors; *general systems subcommittee of the AIEE committee on power transmission and distribution. 30 cents.* The Institute is at present fostering a program for encouraging discussion of means for obtaining greater loading out of existing equipment. As part of this program the general systems subcommittee of the power transmission and distribution committee has undertaken the task of analyzing what can be done with generators of reactive power in reducing the kva demand upon system elements, thereby releasing more of the system capacity for useful kilowatt loading. While this report is concerned primarily with the use of capacitors as generators of kilovars, many of the conclusions drawn herein can be applied equally to other generators of kilovars, such as overexcited synchronous machines.

Protective Devices

43-15—A New Generator Differential Relay; *A. J. McConnell* (*A '36*). *15 cents.* A new differential-relay principle, product restraint, is discussed specifically as applied to a generator differential relay. Restraining in response to the product of the incoming and outgoing currents rather than to their sum, the so-called restraining windings produce, during an internal fault, either

1. An operating force, if there is an external source of power.

2. No force at all, if there is no external source.

Consequently, there is no danger of failure to operate during an internal fault even if the differential (operating) circuit is sharply saturated. During a through fault, sharp saturation of the differential circuit provides, as the current level increases, a proportionately rapid increase in the slope characteristic, thereby causing the relay to be insensitive to the false differential current which may appear at the higher current levels because of d-c saturation of the current transformer. A relay incorporating the product-restraint principle is described.

43-19—Switching Overvoltage Hazard Eliminated in High-Voltage Oil Circuit Breakers; *Lloyd F. Hunt* (*F '38*), *E. W. Boehne* (*M '37*), *H. A. Peterson* (*M '41*). *15 cents.* In this paper a specific problem of high transient switching voltages on the 220-kv lines of the Southern California Edison Company, Ltd., is discussed. After the symptoms were diagnosed from a theoretical standpoint, a complete analysis was made, using the transient analyzer to determine the possible magnitudes of switching overvoltages under various possible system-operating conditions. Different means of subduing these over voltages were carefully considered, in the light of experience in related fields, and it was concluded that equipping the circuit breakers with internal resistors of the proper ohmic value afforded the best solution. The effectiveness of the method described in controlling the switching overvoltage hazard is significant, not only from the circuit-breaker standpoint, but from the arrester, relaying, and over-all system-operating standpoint as well, since lines and terminal equipment are freed from the possibility of being subjected to destructive switching overvoltages, regardless of the method of system neutral grounding.

43-27—Pilot-Wire Circuits for Protective Relaying—Experience and Practice; *relay subcommittee of the AIEE committee on protective devices. 15 cents.* Because of the increasing use of pilot-wire relays, and particularly for longer lines, the relay subcommittee initiated an investigation of the operating experience with the pilot channel itself. From this investigation it was hoped to determine the requirements for a reliable pilot channel. Unfortunately, the information obtained to date is not conclusive, and under war conditions the completion of this investigation appears to be unavoidably delayed. On the other hand, plant expansion necessary to the war effort has frequently called for quick decisions on relay schemes, and pilot wires have been used in many cases. Because the pilot-wire channel is the least known item in the pilot-wire relay scheme, the committee is publishing in this report the information now available to indicate the trend, so that prospective users of pilot-wire relaying may have the benefit of this preliminary work.

43-28—The Effect of Current-Transformer Residual Magnetism on Balanced Current or Differential Relays; *H. T. Seeley* (*A '27*). *20 cents.* High-speed current-balance relaying has been subject to occasional false tripping that has not been explained satisfactorily. Field and factory tests now show that this probably is due to differences in residual fluxes in the current-transformer cores. The limiting value of these fluxes can be calculated approximately, and they can be measured with portable instruments connected to the secondary winding. They may cause a deficiency in secondary current, especially during the first half-cycle of fault current, which will cause current-balance or differential-over current relays to operate falsely. This false operation can be avoided by the addition of a short inherent or external time delay with relays having a high dropout, or by the use of special current transformers.

32-32—An Improved Axial Air-Blast Interrupter for Severe Operating Duty; *P. L. Taylor* (*A '27*), *H. W. Martin* (*A '40*). *30 cents.* The development of an improved axial air-blast interrupter, whose performance permits long contact life at high currents, is reported. The evolution of the new interrupter is described and illustrated. Difficulties experienced during tests on successive arrangements of the device during its evolution are mentioned, and the means by which such difficulties were overcome are explained. A description of the 150,000-kva 5-kv vertical-lift breaker, incorporating the new interrupter, is included, and performance test data are submitted. The test data show the device to be capable of interrupting the lowest- to the highest-rated interrupting currents with a maximum arcing time of one current loop. Based on the test evidence submitted, the conclusion is reached that the device may be expected to require very infrequent contact replacement or maintenance and that it is capable of meeting the requirements of the most exacting applications.

43-37—Performance Requirements for Relays on Unusually Long Transmission Lines; *F. C. Poage* (*M '38*), *C. A. Streifus* (*A '36*), *D. M. MacGregor* (*A '37*), *E. E. George* (*F '36*). *30 cents.* This paper reexamines the fundamental principles of transmission-line relaying in view of the requirements of a 270-mile 154-kv interconnection between two systems. Of the possible bases—current, phase-angle, impedance, and impedance angle—the combination of impedance magnitude Z and impedance angle $\psi = \tan^{-1} X/R$ is chosen as most promising. Impedance circle diagrams for the interconnection are developed and plotted on resistance-reactance coordinates. By means of these diagrams there is charted the dynamic behavior of the systems during faults and surges of synchronizing power. The desirable areas of "trip" and "no-trip" are mapped, and general specifications for the performance of relay systems are presented in terms of impedance magnitude and angle $Z \angle \psi$. This permits taking full advantage of all the possible synchronizing power inherently available over the interconnection and at the same time permits relays properly to recognize faults and the approach of out-

of-step condition. The principles developed are applicable to circuits of any length over which it is possible to maintain synchronism between constant voltage systems. This is one of a group of three related papers. Papers 43-38 and 43-39 cover design of relays in accordance with these principles and staged-fault tests on the completed interconnection.

43-38—Protective Relaying for Long Transmission Lines; *A. R. Van C. Warrington* (*A '31*). *20 cents.* Some of the new system interconnections necessitated by war needs have had to be unusually long. Conventional distance and carrier relays are not applicable to very long lines, because the impedance they measure under load or power-swing conditions may be low enough to make them trip wrongly. The paper describes a new method of relaying which uses phase angle to distinguish between normal and abnormal conditions which present similar impedance to the relays. The new method has the advantages that

(*a*). Tripping an out-of-step conditions is provided and blocking on power-swing conditions.

(*b*). The degree of system separation that is desired for tripping can be set accurately.

(*c*). No time is required to recognize out-of-step conditions.

The protective relays are associated with an unusually flexible arrangement for controlling manual and automatic reclosing, both instantaneously and by voltage and synchronism check. Reactors are cut in automatically to prevent overvoltage on single-end feed.

43-39—Staged-Fault Tests of Relaying and Stability on Kansas–Nebraska 270-Mile 154-Kv Intercomnection; *C. W. Minard, R. B. Gow* (*A '35*), *W. A. Wolfe* (*M '36*), *E. A. Swanson. 30 cents.* This paper presents results and conclusions from 22 staged-fault tests made on a 154-kv transmission line and the terminal systems to check the characteristics and performance of newly developed long-line relays which were designed to discriminate between faults and high power swings. Observed power swings and relay performance are compared with predictions made on basis of network-calculator studies and design of relays. Also presented are data on the transient-stability limit of the interconnection, observations made during the tests, measured values of line constants, and results of carrier-current attenuation tests. Description is given concerning manner of initiating the faults, scheduling the power flows, and organization of personnel for the tests.

43-44—A New 50,000-Kva–5 Kv Oilless Circuit Breaker and Metal-Clad Switchgear Unit; *R. C. Dickinson* (*M '41*), *B. I. Hayford* (*A '23*). *15 cents.* Progress in the development of the larger air-interrupting devices, careful cost analysis, and improved manufacturing methods have made it possible to produce economically a 50,000-kva interrupting-capacity unit comparable in space requirements and height with the corresponding oil circuit breaker. A metal-clad switchgear unit has been designed to utilize the new air circuit breaker, and the performance of the complete unit is demonstrated by high-power laboratory tests.

43-51—A Vertical-Flow Compressed-Air Circuit Breaker and Its Application on a 132-Kv Power System; *H. A. P. Langstaff* (*M '27*), *B. P. Baker* (*M '41*). *15 cents.* The compressed-air circuit breaker for indoor powerhouse service is becoming very popular. However, its use for high-voltage outdoor service is still in the field-trial stage. Several high-voltage porcelain-clad circuit breakers of American design are now in service, and their performance is being carefully watched. A 138-kv 1,500,000-kva three-pole breaker has been installed at the Kittanning substation of the West Penn Power Company. Before installation, its interrupting ability was checked to 5,900 amperes with full 132 kv on a single-pole unit and on a circuit with a transient-recovery rate of 3,100 volts per microsecond. The mechanical operation was tested with the breaker in a heavily iced condition at −14 degrees Fahrenheit. The air supply system was tested at −4 degrees Fahrenheit. Both were found to operate satisfactorily. The breaker was installed on the most active line of the West Penn Power system. Since then it has had 41 operations, five of which were on faults. Its operation to date has been satisfactory in every detail, and it is hoped that this new device will meet operating requirements and materially reduce the time outage for servicing such apparatus.

43-52—The Autoblast Interrupter Switch; *E. A. Williams, Jr.* (*M '42*), *W. G. Harlow* (*A '42*). *20 cents.* An air interrupter switch may be defined as a nonautomatic air switch which combines the functions of a disconnecting switch with the ability to interrupt current up to a predetermined magnitude. It differs primarily in function from a circuit breaker in that it cannot interrupt overload or short-circuit currents. General specifications for interrupter switches are proposed. The autoblast interrupter switch is an air interrupter switch having each pole equipped with an arc chute into which the arc is driven by a blast of air generated automatically when the switch is opened. Interruption occurs within the chute by elongating and cooling the arc. The construction and operation of this switch is described, and test data are presented to show compliance with the proposed general specifications.

43-53—A Multiorifice Interrupter for High-Voltage Oil Circuit Breakers; *L. R. Ludwig* (*M '41*), *W. M. Leeds* (*M '38*). *25 cents.* Present-day requirements relating to the manufacture and operation of high-voltage oil circuit breakers demand the least use of critical materials and the minimum time out of service for inspection and maintenance. While multibreak designs for high-speed three-cycle breakers have shown satisfactory performance, a comparison between such contacts and the simpler structures used in conventional two-break assemblies for eight-cycle operation suggests the desirability of reversing the trend toward a large number of breaks. By making use of newly developed and highly effective multiorifice oil-flow interrupting units, it appears practical to build even the highest-speed breakers with but two interrupting units per pole. High-power laboratory tests on low magnetizing and charging currents, as well as short-circuit currents corresponding to interrupting ratings of 2,500,000 kva and above, have demonstrated the exceptional arc-extinguishing effectiveness and low arc-energy dissipation of the multiorifice interrupter in high-speed oil circuit breakers.

43-54—Oil-Impregnated-Paper High-Voltage Capacitor Bushings for Circuit Breakers and Transformers; *H. J. Lingal* (*M '41*), *H. L. Cole* (*M '21*), *T. R. Watts* (*M '34*). *25 cents.* Oil-impregnated-paper high-voltage capacitor bushings are made in ratings 92 to 230 kv, with capacitors wound from uncoated paper. The bushings have both ends encased in porcelain to retain permanently the superior electrical characteristics obtained by combining the advantages of capacitor-type construction with those of oil-impregnated-paper insulation. Complete interchangeability of bushings is obtained for transformers and circuit breakers of current design. They may also be used interchangeably with most bushings of older design. The construction and treating is described, and a discussion of electrical and mechanical tests is included.

43-55-ACO*—Preliminary Report on Guides for Application and Operation of Circuit Breakers and Switchgear; *AIEE subcommittee on circuit breakers, switches, and fuses. 15 cents.* The present war emergency makes it necessary that maximum use be made of existing equipment and that a minimum amount of critical materials be used for new equipment. To this end guides have been prepared as an aid to those involved in the application and operation of circuit breakers and switchgear. The maximum utilization of existing switching equipment may be realized if the following procedures are adopted:

1. Provision of means for increasing current-carrying capacity.
2. Provision of means for increasing interrupting capacity of circuit breakers.
3. Institution of maintenance practices to minimize failures and resulting destruction of critical materials.

These guides are intended to cover equipment of the following types:

1. A-c power circuit breakers above 600 volts both indoor and outdoor (American Standards C37.4 to C37.9 inclusive).
2. Air disconnecting switches (AIEE Standard 22).
3. Switchgear assemblies (AIEE Standard 27).
4. Current-limiting reactors (American Standards C57.1 to C57.3 inclusive).

The present recommendations include reactors, as this type of equipment is

*ACO—Advance copies only available; not intended for publication in AIEE *Transactions.*

intimately associated with circuit breakers and switchgear and is frequently installed in switching structures.

43-63—Application of Lightning-Protective Devices in Wartime; *I. W. Gross (M '40). 15 cents.* The application of protective devices is reviewed in the light of possible savings in critical materials and man hours. It is pointed out that the indirect savings resulting from a careful selection and application of arresters may amount to far more than elimination or reduction in materials used in the arresters themselves. Among the considerations presented and discussed are:

1. Applying arresters on the basis of 60-cycle rating.
2. Use of line-type in place of station-type arresters.
3. Protection of equipment not already protected.
4. Rebuilding or revamping existing arresters.
5. Use of protective devices other than the conventional lightning arrester.
6. Reduction in length of arrester leads.
7. Location of the arrester close to the equipment to be protected.
8. Testing arresters.

SECTION • • • • •

Washington Section Holds Joint Meeting With ASCE and ASME

Material conservation and production problems in the war effort was the theme of a joint meeting of the Washington Section of the AIEE with the American Society of Civil Engineers and the American Society of Mechanical Engineers on Wednesday evening, December 9, 1942, at the Department of Commerce Auditorium, Washington, D. C. Brigadier General W. H. Harrison (F '31) AIEE past president, vice-president on leave from the American Telephone and Telegraph Company, New York, N. Y., now serving as director of procurement, headquarters, Services of Supply, United States Army, addressed the gathering of about 700 persons. Pointing out instances of Army sacrifices of critical material in one branch to provide it for other more important manufacture, he stated, "In the effort to accelerate the program of conservation we are trying to avail ourselves of every particle of information obtainable from our allies and our enemies."

PERSONAL • • • •

H. H. Wagner (A '29, M '37) electrical engineer, Pennsylvania Transformer Company, Pittsburgh, Pa., has recently been appointed chief electrical engineer. He first joined the company in 1932 as design and development engineer in charge of the design of power and distribution transformers, later becoming electrical engineer. He received the degrees of bachelor of arts (1925) from Culver-Stockton College, bachelor of science in electrical engineering (1927) from the University of Illinois, and master of science in electrical engineering (1933) from the University of Pittsburgh. From 1927 to 1928 he was enrolled in the graduate student course of Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., and from 1928 to 1930 he was employed in the power transformer department as electrical design engineer at the Westinghouse company in Sharon, Pa. Prior to his affiliation with the Pennsylvania Transformer Company in 1932 he was with the Pittsburgh transformer works, Allis-Chalmers Manufacturing Company (1930–32) as electrical design engineer in charge of the technical data department. **H. D. Salton** (A '37, M '41) development engineer, Pennsylvania Transformer Company, Pittsburgh, has been appointed chief design engineer. He was graduated from the Technical University of Darmstadt, Germany, in 1923 with a degree in electrical engineering. In 1924 he entered the employ of the German General Electric Company, Berlin, as designing engineer in the transformer department. He continued his association with that company until 1933, ultimately becoming division manager. In that year he became a consulting engineer engaged in transformer design. In 1936 he came to the United States and joined the Pennsylvania Transformer Company as development and research engineer. He has been with the company continuously since that time.

A. C. Farmer (A '35) assistant manager, transformer sales department, Sharon, Pa., has been named assistant to the vice-president. He received the degree of bachelor of science in electrical engineering in 1908 from the University of London, England, and in 1909 joined the Westinghouse company in the student course at East Pittsburgh, Pa. From 1910 to 1918 he served in the transformer section, and was appointed manager of the distribution transformer section of the supply department in the latter year. He became manager of distribution apparatus sales at headquarters in East Pittsburgh, Pa., and was named assistant sales manager at Sharon, Pa., in 1932. **R. L. Whitney** (A '21, M '28) sales manager, porcelain department, Westinghouse Electric and Manufacturing Company, Derry, Pa., has been appointed sales manager of the company's transformer division, Sharon, Pa. He was graduated from the University of Colorado in 1920 with the degree of bachelor of science in electrical engineering and immediately joined the Westinghouse company in the power sales department, East Pittsburgh, Pa. He was subsequently transferred to the sales office in Philadelphia, Pa., and later, to the sales office in Allentown, Pa., where he became sales manager in 1931. He was transferred to the porcelain department, Derry, Pa., in 1936, in the same capacity. **A. P. Bender** (A '18) former sales manager, transformer division, Sharon Pa., has been made assistant sales manager "to afford the best possible opportunity for his complete recovery" from an extended illness. He has been with the company since 1906.

G. M. Stevens (A '22) assistant manager, River Works, General Electric Company, Lynn, Mass., recently has been appointed acting manager. He has been with that company since 1899, when he entered the four-year apprentice course at the River Works. From 1904 to 1912 he was employed as executive on various lines of motor manufacturing, joining the gear and motor department in the latter year. In 1916 he was sent to Russia to assist in the installation of electrical apparatus. Upon his return to the United States in 1917 he was named superintendent of the company's plant at Taunton, Mass., and in 1925 was transferred to the River Works as general manufacturing superintendent. He became general superintendent there in 1929, and was appointed assistant manager in 1940. **N. M. DuChemin** (A '29) assistant manager, West Lynn Works, Lynn, Mass., has been appointed acting manager. He first became associated with the General Electric Company in 1914 as apprentice machinist at the River Works. He served during the World War I as ensign in the United States Navy, and upon his return to the General Electric Company in 1919, was assigned to the turbine department at the River Works. In 1923 he became general superintendent of the West Lynn Works, and in 1935 he was appointed assistant manager.

R. H. Tapscott (A '18, F '29) president, Consolidated Edison Company of New York (N. Y.), Inc., has been named that company's chief executive officer. He was born in Brooklyn, N. Y., on August 31, 1885, and was graduated from Union College in 1909 with the degree of bachelor of science in electrical engineering. He immediately joined General Electric Company, Schenectady, N. Y., in the testing department, and from 1910 to 1917 he served in the lighting engineering department. In 1917 he became assistant electrical engineer, New York (N. Y.) Edison Company. He served in this capacity until 1924, when he was appointed electrical engineer. In 1932 he became vice-president of that company and of the United Electric Light and Power Company, New York, N. Y. He became a director of both companies in 1935. In 1936 he was elected vice-president of the Consolidated Edison Company of New York when the New York Edison Company, Inc., was merged with the Consolidated Edison Company. He has served as president and trustee of the Consolidated Edison company since 1937. He is a past vice-president (1934–36) and a past director (1930–34) of the Institute.

C. F. Wagner (A '20, F '40) manager of central-station engineering, and **Dean Harvey** (A '04, M '13) materials and standards engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., have been awarded the Westinghouse Order of Merit for outstanding contributions to the electrical industry. Mr. Wagner was honored for his studies in lightning and for his practical application of mathematics to power system analysis

machine characteristics, and short circuit calculation. He joined the Westinghouse company in 1918 in the research division, and was transferred to the engineering division in 1924, where he was concerned with power transmission developments. Mr. Harvey was cited for his contribution to the war effort as a member of the conservation division of the War Production Board and for pioneering work in the development of materials and process specifications both within the company and for national organizations. He joined the Westinghouse company in 1904 as a design engineer on detail apparatus, insulation, and switchboards. Since 1911 he has prepared specifications for materials and methods of testing at the East Pittsburgh works.

W. A. Schumacher (M '27) outside plant engineer, plant and engineering department, Postal Telegraph-Cable Company, New York, N. Y., has recently been appointed superintendent of plant. He received the degree of bachelor of science in electrical engineering in 1917 from the University of Nebraska. From 1917 until 1920 he was variously associated with Northwestern Telephone Exchange Company in their St. Paul, Minneapolis, and Virginia, Minn., offices. In the latter year he was appointed wire chief at Fargo, N. Dak., for the Northwestern Bell Telephone Company, and in 1922 he was transferred to Omaha, Nebr., to become assistant to the construction engineer. He became engineer in charge of provisional estimates and outside plant engineering practices later in the same year, construction engineer and engineer of outside plant engineering practices in 1923, and division plant engineer in 1926. He entered the employ of Postal Telegraph-Cable Company in 1929, where he has been serving continuously since as plant engineer.

H. S. Osborne (A '10, F '21) plant engineer, operation and engineering department, American Telephone and Telegraph Company, New York, N. Y., has recently been made assistant chief engineer of that department. He received the degrees of bachelor of science in electrical engineering (1908) and doctor of engineering (1910) from Massachusetts Institute of Technology. He entered the engineering department of the American Telephone and Telegraph Company in 1910, and became assistant to the transmission and protection engineer in 1914. In 1920 he was appointed transmission engineer, and in 1939 he became operating results engineer in the operation and engineering department. He was appointed plant engineer in 1940. Doctor Osborne is a past director of the Institute and is currently serving as AIEE president (*EE, Mar. '42, p. 162*).

C. K. Strobel (A '24, M '30) research physicist, research department, Robertshaw Thermostat Company, Pittsburgh, Pa., has been appointed assistant director of the research laboratory. He received the degrees of bachelor of science in electrical engineering in 1921 from Carnegie Institute of Technology, and master of science in physics from the University of Pittsburgh in 1933. He has been associated with the Robertshaw company since 1940, and prior to that time had conducted both individual and group research with Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., in the research department of Union Switch and Signal Company, Swissvale, Pa., and in the development laboratory of Western Electric Company, New York, N. Y.

K. L. Hansen (A '17, F '34) consulting engineer, Harnischfeger Corporation, Milwaukee, Wis., has been elected president of the American Welding Society for 1942–43. He is a past vice-president of this organization, and a past vice-president of the American Institute of Electrical Engineers, representing the Great Lakes District (5) 1940–42.

R. T. Henry (A '24, F '33) assistant chief electrical engineer, engineering department, Buffalo, Niagara, and Eastern Power Corporation, Buffalo, N. Y., has been appointed chairman of the electrical equipment committee of the Edison Electric Institute for 1942–43.

OBITUARY ....

Azel Ames (A '09) sales engineer and engineering executive, power cable department, the Kerite Insulated Wire and Cable Company, Inc., New York, N. Y., died on November 23, 1942. He was born in Wakefield, Mass., on January 3, 1873, and received the degree of bachelor of science in civil engineering in 1895 from Massachusetts Institute of Technology. He immediately joined the Boston and Maine Railroad Company, serving as assistant engineer until 1896, and as track laborer and sub-foreman until 1898. During the Spanish-American War he served as captain in the United States Volunteer Engineers Corps, accompanying an expedition to Puerto Rico in 1899. In 1899 he became associated with the New York Central and Hudson River Railroad as assistant roadmaster, becoming supervisor of track later in the same year. From 1901 to 1904 he was associated with the Boston and Albany Railroad, first as roadmaster (1901–02) and later as signal and electrical engineer (1902–04). Following brief associations as signal engineer with the Lake Shore and Michigan Southern Railway (1904–06) and with the New York Central and Hudson River Railroad (1906–08), he joined the Kerite Insulated Wire and Cable Company, Inc., New York, N. Y., serving until his death. During World War I he served as a major in the United States Army Coast Artillery, and was retired in 1939 as colonel of the United States Army Coast Artillery Officers Reserve Corps. Colonel Ames also served as a member of the block signal and train control board of the Interstate Commerce Commission from 1907 to 1912.

Charles N. Ruess (A '25) superintendent of general shops, general plant division, Department of Water and Power, City of Los Angeles, Calif., died on September 7, 1942. He was born August 9, 1882, in Downers Grove, Ill., and entered upon his first association with the electrical industry in 1900 with the Western Electric Company, Chicago, Ill. He interrupted his association with this company in 1904 to become electrician and repairman, first with United Verdie Copper Company, Tucson, Ariz. (1904–05), and later with Calumet and Arizona Copper Company, Bisbee (1905–06). In 1906 he returned to the Western Electric Company, Chicago, Ill., serving in general assembly and installation work and as traveling repairman until 1909. In that year he joined the Department of Water and Power, City of Los Angeles, Calif., as superintendent of electrical maintenance at the Monolith cement plant on the Los Angeles Aqueduct project. In 1910 he was placed in charge of the aqueduct electric salvage section, and from 1915 to 1916 he was loaned to the County of Los Angeles as chief electrician and general foreman of the Monolith (Calif.) Cement Plant. In 1917 he was recalled by the city of Los Angeles to supervise the electrical repair shop in the newly organized Bureau of Power and Light and remained in this capacity until 1934, when he was appointed superintendent of general shops.

Charles E. Carpenter (A' 96) owner, Carpenter Laboratories, Hopewell Junction, N. Y., died on November 9, 1942. He was born on April 1, 1864, at Big Flats, New York, and attended Cornell University and the University of Minnesota. In 1890 he invented an enamel rheostat for controlling electric motors and generators, and established a new company, the Carpenter Enamel Rheostat Company, New York, N. Y., of which he became vice-president. In 1895 he joined the Ward Leonard Electric Company, Mount Vernon, N. Y., as vice-president, and during his association with this company he was awarded a gold medal at the 1898 Paris Exposition for his inventions. He formed the Carpenter Enclosed Rheostat Company in 1900, and in 1903 he joined the Cutler-Hammer Manufacturing Company of Milwaukee, Wis., in their New York office. He continued his affiliation as engineer in the mechanical and electrical engineering department of this company until his retirement in 1929. In 1930 he established the Carpenter Laboratories on his estate at Hopewell Junction, which he maintained until his death. He was the holder of numerous patents, among them an automatic device for controlling flat-bed printing presses, and a hydraulic governor which is used extensively to control large alternating current motors on high speed rotary presses.

Ralph B. Ward (A '24, M '26) retired chief of the electrical bureau, Newark (N. J.) Department of Public Safety, died July 26, 1942. He was born on January 25, 1882, in Newark, N. J., and began his engineering career in 1904, supervising the design and construction of switchboards for HOS Engineering Company, Newark, N. J. In 1907 he joined the Davis Electric Company, Newark, N. J., as foreman electrician, becoming superintendent of the designing and laying out of electrical installations in 1909. He became assistant electrical inspector in 1914 for Newark (N. J.) Department of Public Safety and from 1918 until his retirement in 1941 he served as chief electrical inspector and executive of the electrical bureau there.

MEMBERSHIP

Recommended for Transfer

The board of examiners, at its meeting on December 17, 1942, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the national secretary.

To Grade of Fellow

Bryant, J. M., professor of electrical engineering, University of Minnesota, Minneapolis, Minn.
Henline, H. H., national secretary, AIEE, New York, N. Y.
Johnson, P. L., acting chief engineer, Southern California Telephone Company, Los Angeles, Calif.

3 to grade of Fellow

To Grade of Member

Carey, F. K., district engineer, Westinghouse Electric Elevator Company, Los Angeles, California.
Dzwonczyk, V. L., electrical engineer, American Gas and Electric Service Corporation, New York, N. Y.
Eck, R. N., assistant supervising engineer, Cutler-Hammer, Inc., Milwaukee, Wis.
Grow, L. M., division superintendent, Southwestern Public Service Company, Plainview, Tex.
Howse, S. E., engineering supervisor, Technicolor Motion Picture Corporation, Hollywood, Calif.
Kieb, N. A., electrical engineer, Albert Kahn, Inc., Detroit, Mich.
Love, G. A., manager, electrical engineering department, Robert and Co., Jacksonville, Fla.
Prescott, H. L., development engineer, Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Rystedt, T., engineer, Western Union Telegraph Company, New York, N. Y.
Sohon, Harry, assistant professor of electrical engineering, University of Connecticut, Storrs.
Stark, Guy F., Owner, Stark Electric Co., Baltimore, Md.

11 to grade of Member

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. Names of applicants in the United States and Canada are arranged by geographical District. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the national secretary before January 31, 1943, or March 31, 1943, if the applicant resides outside of the United States or Canada.

United States and Canada

1. North Eastern

Alexander, E. H. (Member), General Electric Company, Schenectady, N. Y.
Archibald, J. F. (Member), Boston Edison Company, Boston, Mass.
Jones, W. L. Jr., General Electric Company, Schenectady, N. Y.
Judkins, F. H., General Electric Company, Pittsfield, Mass.
Marston, H. S., Westinghouse Electric and Manufacturing Company, Boston, Mass.
Maser, H. T. (Member), General Electric Company, Schenectady, N. Y.
Peterson, D. A., Dewey and Almy Chemical Company, Cambridge, Mass.
Salzer, E., 45 St. Paul St., Brookline, Mass.
Schauer, A. H., George Keller Machinery Company, Buffalo, N. Y.

2. Middle Eastern

Ackor, W. R. (Member), E. C. Ernst, Incorporated, Washington, D. C.
Albrittain, M. C., Consolidated Gas, Electric Light and Power Company, Baltimore, Md.
Andrews, F. A. (Associate re-election), Consolidated Gas, Electric Light and Power Company, Baltimore, Md.
Bennett, F. C., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Bernhard, G. K. (Associate re-election), Board of Education, Cleveland, Ohio.
Bliss, D. S. (Associate re-election), Bliss Electrical School, Takoma Park, Md.
Bozarth, R. M., Philadelphia Navy Yard, Philadelphia, Pa.
Brandenburg, G. F., Consolidated Gas Electric Light and Power Company, Baltimore, Md.
Ciccarelli, W. E., I.T.E. Circuit Breaker Co., Philadelphia, Pa.
De Kiep, J. (Member), Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
De Shazo, J. S. (Associate re-election), Pennsylvania Power and Light Company, Hazleton, Pa.
Doyle, C. E., U. S. Engineer Corps, Cincinnati, Ohio.
Fitzgerald, J. W., Naval Research Laboratory, Sound Division, Washington, D. C.
Gray, J., General Electric Company, Philadelphia, Pa.
Hall, A. I. (Associate re-election), Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Hanson, E. T. (Associate re-election), United States Navy Yard, Philadelphia, Pa.
Hobart, T. D., Naval Research Laboratory, Anacostia, D. C.
Holmquist, A. S., The Ohio Public Service Company Massillon, Ohio.
Hunt, J. H. (Associate re-election), The Toledo Edison Company, Toledo, Ohio.
Kelly, E. L., Consolidated Gas, Electric Light and Power Company, Baltimore, Md.
Lamb, H. P., Adamson Machine Company, Akron, Ohio.
Lloyd, R. E., Navy Department, Bureau of Ships, Washington, D. C.
Shelhorse, C. H., Eastern Shore Public Service Company, Salisbury, Md.
Vargo, W. S., Westinghouse Electric and Manufacturing Company, Sharon, Penna.
Wenk, W. J., United States Navy, Mine Warfare Group, Planning Division, Navy Yard, Philadelphia, Pa.
Ziegenfuss, H. E. (Associate re-election), Consolidated Gas Electric Light and Power Company, Baltimore, Md.

3. New York City

Aster, A. K. (Associate re-election), Westinghouse Electric Elevator Company, Jersey City, N. J.
Boss, B. B., Gibbs and Hill, Incorporated, New York, N. Y.
Bostonian, E. T., General Electric Supply Corp., Brooklyn, N. Y.
Browning, L. C., Westinghouse Electric and Manufacturing Company, Newark, N. J.
Buchtenkirch, A. J., Guided Radio Corp., New York, N. Y.
Cliver, E. K. (Associate re-election), Celanese Corporation of America, Newark, N. J.
Crow, W. A., War Department, Signal Corps, Fort Monmouth, N. J.
Derfler, T. A., Bruce Engineering Company, New York, N. Y.
Duffy, E. H., Sperry Gyroscope Company, Incorporated, Brooklyn, N. Y.
Ekholm, J. F., Sanderson and Porter, New York, N. Y.
Feiring, F. C. (Member), 55 Vandam St., New York, N. Y.
Firth, F. G., Philips Metalix Corporation, Mt. Vernon, N. Y.
Fruit, P. L., Gibbs and Hill, Incorporated, New York, N. Y.
Haller, C. E., R. C. A. Manufacturing Company, Harrison, N. J.
Kozlowski, E. W., George G. Sharp, New York, N. Y.
Lederer, M. R. (Member), George W. Gates and Company, Incorporated, Franklin Square, L. I., N. Y.
Levin, R., Phillips Electrical Company, New York, N. Y.
Lewis, H. M. (Member), Hazeltine Corporation, Allenhurst, N. J.
Nelson, J. M. (Member), Westinghouse Electric and Manufacturing Company, Newark, N. J.
Oneal, L. E. (Member re-election), 15 Exchange Place, Jersey City, N. J.
Rienstra, A. R. (Associate re-election), Bell Telephone Laboratories, Incorporated, New York, N. Y.
Ritchie, A. E., Bell Telephone Laboratories, Incorporated, New York, N. Y.
Slack, C. M. (Member), Westinghouse Lamp Division, Bloomfield, N. J.
Slade, H. B., The Okonite Company, Passaic, N. J.
Soares, E. C. (Member re-election), 75 West St., New York, N. Y.
Stauber, T. W., American Transformer Company, Newark, N. J.
Stearn, F. A. (Member re-election), International Telephone and Radio Corp., Newark, N. J.
Steiner, O. C. (Member), Crocker Wheeler Electric Manufacturing Company, Ampere, N. J.
Stone, H. A., Jr., Bell Telephone Laboratories, Incorporated, New York, N. Y.
Valentine, D. H. (Associate re-election), New Jersey Bell Telephone Company, Newark, N. J.
Wennemer, G. P., Bell Telephone Laboratories, Incorporated, New York, N. Y.
Yeakle, R. B. (Associate re-election), General Cable Corporation, Bayonne, N. J.
Zezza, C. F., Gibbs and Hill, Incorporated, New York, N. Y.

4. Southern

Lindemann, W. E., Tennessee Valley Authority, Wilson Dam, Ala.
Mayer, L. F., Atmospheric Nitrogen Corporation, Hopewell, Va.
Nix, R. C., Tennessee Valley Authority, Douglas Dam, Jefferson City, Tenn.
Taylor, H. G. (Member), Southern Electric Service, Company, Greensboro, N. C.
Witkowski, T. T., U. S. Army, Corps of Engineers, c/o Postmaster, New Orleans, La.

5. Great Lakes

Doyle, F., Chicago District Electric Generating Corp., Hammond, Ind.
Herrmann, F. W., Columbia Broadcasting System, Minneapolis, Minn.
Hurd, F. (Member), 407 South Dearborn St., Chicago, Ill.
Malleris, C. F., Fairbanks, Morse and Company, Beloit, Wisc.
Reeb, C. A., Kerite Insulated Wire and Cable Company, Chicago, Ill.
Roney, R. M., War Department, Chanute Field, Ill.
Schulman, H. M., A. S. Schulman Electric Company, Chicago, Ill.
Schwarzlose, P. F., University of Illinois, Urbana, Ill.
Webb, F. G., Commonwealth Edison Company, Chicago, Ill.
Woo, A. S. F. (Associate re-election), Allis-Chalmers Manufacturing Company, West Allis, Wisconsin

6. North Central

Blind, H. J., United States Naval Reserve, Casper, Wyo.
Wicks, P., University of Colorado, Boulder, Colo.

7. South West

Boudreaux, E. A., Southwestern Bell Telephone Company, Houston, Texas.
Gilbert, M. G. (Associate re-election), Empire District Electric Company, Joplin, Mo.
Gutsch, O. H., Southern Pacific Lines, El Paso, Texas.
LeVelle, A. S., Southwestern Bell Telephone Company, Dallas, Texas.
Meyer, E. C. (Member), Rural Electrification Administration, St. Louis, Mo.
Price, C. R., Rural Electrification Administration, St. Louis, Mo.
Scott, F. B. (Member), Rural Electrification Administration, St. Louis, Mo.
Stones, B. V. R., Washington University, Lindelland Skinker, St. Louis, Mo.

8. Pacific

Aufdemberg, O. H., Consolidated Steel Corporation, Wilmington, Calif.
Fellows, R. C. (Member), General Cable Corporation, Emeryville, Calif.
Keith, A. H., Consolidated Aircraft, San Diego, Calif.
McCarty, I. H. (Associate re-election), Butte Electric and Manufacturing Company, San Francisco, Calif.
Tahallon, R., Richmond Shipyard No. 1, Richmond, Calif.

9. North West

Arents, C. A., Bonneville Power Administration, Portland, Ore.
Homchick, A. J., Northwestern Electric Company, Portland, Ore.
Mauldin, C. W., Army Air Force, First Communications Squadron (Det.), Gowen Field, Boise, Idaho.
Morrison, G. I., Washington Water Power Company, Spokane, Wash.
Morse, E. L., Washington Water Power Company, Spokane, Wash.
Smallidge, F. E., Washington Water Power Company, Spokane, Wash.
Spencer, J. C., Bonneville Power Administration, Portland, Ore.

10. Canada

Bowlden, J. H., Canadian Westinghouse Company Limited, Hamilton, Ont.
Whelan, R. V., Electrical News and Engineering, Toronto, Ont.

Total, United States and Canada, 107

Elsewhere

de Lascurain, M. M. (Associate re-election), San Juan de Letran 13-413, Mexico, D.F., Mexico.
deOlarte, H. A. (Member), Compania Electrica Cuzco, Peru, South America.
Milne, J. C. (Member), Electric Construction Company, Wolverhampton, England.
Wilkinson, J. R. (Fellow), Ferguson Pailin Limited Manchester 11, England.

Total, elsewhere, 4

OF CURRENT INTEREST

Army and Navy Announce Details of College Training Programs

Joint Statement of the Secretary of War and the Secretary of the Navy on Utilization of College Facilities in Specialized Training for the Army and Navy

With the demands of a mechanical war and of steadily growing armed forces, the Army, Navy, Marine Corps, and Coast Guard are in need of a flow into their respective services of large numbers of young men who require specialized, educational, technical training. Their own facilities of teaching staff and equipment are not sufficient for these needs. The colleges and universities will have such facilities available. Consequently the armed services together have formulated plans to utilize for these needs to the maximum practicable extent the resources of these colleges and universities. In formulating these plans, they have had the benefit of fruitful consultation with many educators, and particularly the staff of the War Manpower Commission, a committee of the American Council on Education, and the Navy Advisory Council on Education. In the administration of these plans, the Army and Navy are counting on further assistance from the same sources.

Both plans contemplate that the educational training will be carried on while the men are on active duty, in uniform, receiving pay, and under general military discipline. The armed services will contract with colleges and universities which will furnish to the men selected by the services instruction in curricula prescribed by the services and also the necessary housing and messing facilities. Selection of those institutions which will be asked to undertake such contracts necessarily will be governed by their facilities for undertaking such responsibilities. The chairman of the War Manpower Commission after consultation with the Secretary of War and the Secretary of the Navy will prescribe the rules and regulations under which institutions of higher learning will be selected for this work. The actual selection will be made by a joint committee consisting of representatives of the armed services and the War Manpower Commission. In the event of failure on the part of the members of the committee to agree, the final decision will be made by the chairman of the War Manpower Commission.

The joint committee shortly will make announcement of its procedure for the selection of institutions and contracts under these plans. Meanwhile, it is requested that institutions themselves do not endeavor to get in touch with Government administrative organizations handling the matter. These organizations have a difficult administrative task ahead. The importance of their doing it in an orderly way will be manifest to all concerned. No institution will receive any advantage by departing from this procedure.

The plans of the Army and Navy, in their fundamentals, are the same, but there are certain variations in the plans of the respective services, because of differences in the laws affecting the two services, and in their requirements and procedures. These variations are in both the permanent plans and the plans for fitting the present members of their respective Enlisted Reserve Corps into the respective permanent programs. The plans will be operated in harmony and with mutual assistance.

Nothing in these new plans will affect existing contracts of the Army or Navy with educational institutions for facilities or training. It is probable that there will continue to be similar special arrangements that will not fall within the framework of the new plans. Such arrangements at present range from the bare leasing of physical facilities to provision for facilities, instruction, and use of equipment. The selection of colleges for such special arrangements will also be subject to rules and regulations prescribed by the chairman of the War Manpower Commission after consultation with the Secretary of War and the Secretary of the Navy and will be coordinated as between the Army and Navy by the joint committee.

The Army Specialized Training Program

(*a*). OBJECTIVE OF THE PLAN

The objective of the plan is to meet the need of the Army for the specialized technical training of soldiers on active duty for certain Army tasks for which its own training facilities are insufficient in extent or character. To that end the Army will contract with selected colleges and universities for the use of their facilities and faculties in effecting such training of selected soldiers in courses prescribed by the Army. This plan will enable the Army to make a selection for this training of qualified young men on a broad democratic basis without regard to financial resources.

(*b*). DESIGNATION OF SOLDIERS FOR TRAINING

1. Except as set forth in (*g*) below, the selection of soldiers for such training will be made from enlisted men who have completed or are completing their basic military training and who apply for selection for specialized training.
2. The selection of enlisted men for such further training will follow the general plan for the selection of enlisted men for Officers Candidate Schools with such additional methods of ascertaining qualifications as may be deemed appropriate after consultation with the American Council on Education.
3. All such selections will be under War Department control.
4. No enlisted man who has passed his 22d birthday will be eligible for selection under this program, except for an advanced stage of technical training.

(*c*). TRAINING UNDER COLLEGE CONTRACTS

1. All selected students will train in the grade of private (seventh grade).
2. Commutation allowances will not be permitted. Quarters and rations will be furnished under government contract.
3. Military training, organized under a cadet system, subordinated to academic instruction, within the time available, will preserve the benefits of basic training and provide for maintenance of discipline and a superior physical condition.

(*d*). SELECTION OF COLLEGES

In the selection of institutions, specific consideration will be given to the following:

1. Standards and equipment for the required instruction.
2. Adequacy of housing and messing facilities.
3. Minimum Army overhead.

(*e*). ACADEMIC STANDARDS OF STUDENTS

1. Standards of academic proficiency to be maintained by students who are trained under this program will be formulated after consultation with the American Council on Education.
2. In this connection, the method of initial selection of students will include such tests as reasonably will assure that the individual selected is intellectually, temperamentally, psychologically, and educationally capable of attaining these standards. Attrition and wastage must be held to a minimum.
3. In order to insure that individual students meet academic standards and to permit prompt relief and reassignment of those not suited for further specialized training, a system for continuous screening will be formulated and applied at all colleges participating in the program.

(*f*). STANDARDIZATION OF CURRICULA

1. To prepare for the particular technical tasks outlined by the various services

for which specialized training under this program is required, appropriate courses will be prescribed by the Army. Curricula will be prepared in consultation with the American Council on Education, looking to the speediest practicable training for such particular technical tasks. Varying with the nature of such tasks, the curricula will call for varying lengths of the period of training. They will also vary as to whether there are basic and advanced stages in any particular course of training. Soldiers selected for training may be assigned to any stage of a prescribed course which their previous training fits them to enter.

2. It is essential, if morale is to be preserved among those taking the program, that the soldier feel that his training, both at elementary and more advanced stages, is pointed directly at fitting him for some concrete military task for which he is being trained.

3. It is important, however, that in the selection and screening exceptional technical ability be identified and conserved, even though it may not prove to fit directly into Army tasks.

(*g*). SPECIAL PROVISIONS FOR SELECTION FOR TRAINING AND FOR THE TERMINATION OF THE ENLISTED RESERVE CORPS

1. Medical students (including dentist and veterinary) in the enlisted reserves will be called to active duty at the end of the first full semester, or substantially corresponding academic period, that begins in 1943 and will be detailed to continue courses of medical instruction under contracts to be made by the War Department with medical schools for facilities and instruction. Medical students who have been commissioned in the Medical Administrative Corps may, at the same time, resign such commissions, enlist as privates, and be detailed in the same manner as medical students in the enlisted reserve.

2. Premedical students in the Enlisted Reserve Corps, taking approved courses, will continue in an inactive status until the end of the first full semester, or substantially corresponding academic period that begins in 1943, and then will be called to active duty. Those selected at induction or at the completion of their basic military training for further medical or premedical training will be detailed for such instruction under the Army specialized training program.

3. Medical and premedical students, not in the Enlisted Reserve Corps, taking approved course, if inducted under Selective Service prior to the end of the first full semester, or substantially corresponding academic period, that begins in 1943, will be placed on inactive duty to continue such course until the end of that semester or period. They then will be called to active duty, at which time they may be detailed for further medical or premedical training under the Army specialized training program or assigned to other military duty.

4. Senior (fourth year) students taking advanced Reserve Officers' Training Corps work (including those in the Enlisted Reserve Corps) will be ordered to active duty upon graduation or upon completion of the first full semester, or substantially corresponding academic period, that begins in 1943, which ever is earlier. Upon entering active duty they will be ordered to their respective branch schools and commissioned upon successful completion of the course.

5. Junior (third year) students in the Enlisted Reserve Corps who are pursuing approved technical engineering courses will continue in an inactive status until the end of the first full semester, or substantially corresponding academic period, that begins in 1943, and then will be called to active duty. Those selected at the completion of their basic military training for further technical training will be detailed for such instruction under the Army specialized training program.

6. Junior (third year) students who are pursuing approved technical engineering courses and are not members of the Enlisted Reserve Corps will, if inducted prior to the end of the first full semester, or substantially corresponding academic period, that begins in 1943, be placed on inactive duty while continuing such technical engineering course until the end of that semester or period. They then will be called to active duty. Those selected at the completion of their basic military training for further technical training will be detailed for such instruction under the Army specialized training program.

7. All other Enlisted Reserve Corps students will be called to active duty at the end of the current semester, or substantially corresponding academic period, and, upon completion of basic training, will be eligible for selection for training under this program or for other military duty.

8. In the event that there appears to be occasion for selecting enlisted men for the Army specialized training program other than in the foregoing manner, requests for approval with reasons for the same will be submitted to the Chief of Staff.

(*h*). DISPOSITION AT THE END OF TRAINING

At the termination of specialized training, whether as a result of screening or completion of a course, the soldier will be selected for:

1. Further training in an Officer Candidate School.
2. Recommended for a technical noncommissioned officer.
3. Returned to troops.
4. In exceptional cases, detailed for very advanced technical training.
5. In very exceptional cases, be made available for technical work to be done out of the Army, but deemed to be highly important to the war effort.]

(*i*). OPERATION OF THE PLAN

1. The assignment of soldiers to the Army specialized training program will begin during the month of February 1943, except for such action as may be required under the same prior to that time.

2. The Commanding General, Services of Supply, is responsible for the operation of the Army specialized training program.

Navy College Training Program

1. GENERAL PURPOSES

In order to provide a continuing supply of officer candidates in the various special fields required by the United States Navy, Marine Corps, and Coast Guard, a new plan for using the facilities of selected colleges and universities for training for Naval service has been established. Under this plan selected high-school graduates, or others of satisfactory educational qualifications, having established their proper mental, physical, and potential officer qualifications by appropriate examinations, will be inducted in the Navy as apprentice seamen or privates, United States Marine Corps, as appropriate, placed on active duty with pay, and assigned to designated colleges and universities to follow courses of study specified by the Navy Department.

This plan will permit selection of the country's best-qualified young men on a broad democratic basis, without regard to financial resources and thus permit the Navy to induct and train young men of superior ability for officers and specialists.

2. STATUS OF PRESENT ENLISTED RESERVES

At a date to be announced, all *V*-1, *V*-5, and *V*-7 reservists regularly enrolled in college as undergraduates will be placed on active duty, as apprentice seamen with full pay, subsistence, and uniforms. In order to carry the present programs to a conclusion and adapt them to the new program, it is contemplated that present enrollees in *V*-1 and *V*-7 will, when placed in active status, be assigned as follows:

(*a*). Those who, on July 1, 1943, have completed six or seven equivalent semesters* may complete two or one additional semesters.

(*b*). Those who at that date have completed five equivalent semesters will pursue a course of two additional equivalent semesters as outlined by the Bureau of Naval Personnel at an institution designated by the Navy.

(*c*). Those who at that date have completed four equivalent semesters will pursue a program of three additonal equivalent semesters, as outlined by the Bureau of Naval Personnel at an institution designated by the Navy.

(*d*). Those who at that date have completed three equivalent semesters will pursue a program of four additional equivalent semesters, as outlined by the Bureau of Naval Personnel at an institution designated by the Navy.

(*e*). Those who at that date have completed one or two equivalent semesters will pursue a program of five or four additional equivalent semesters, respectively, as outlined by the Bureau of Naval Personnel at an institution designated by the Navy.

(*f*). *V*-1 and *V*-7 reservists who are undergraduates and who qualify as medical, dental, and theological students will be continued on active duty as apprentice seamen under instruction in accelerated curricula in approved schools and seminaries until completion of their professional studies.

(*g*). Engineering students who are in good standing in accredited engineering colleges will be allowed a total of *eight* equivalent semesters since their matriculation in college to complete their studies, regardless of the number of equivalent semesters completed as of July 1, 1942.

V-5 Reservists, who are college students and who so requested at the time of enlistment in or transfer to class *V*-5, may be deferred from assignment to specific aviation cadet training until the end of the college year current at the time of such enlistment or transfer.

* The expression, "equivalent semester," as used in this statement, means a term of continuous instruction, approximately 16 weeks in length.

As soon as present V-1, V-5, and V-7 students are placed on active duty, they will be required to spend full time in following courses of training appropriate to each student's previous course of study and as prescribed by the Bureau of Naval Personnel. These courses will be given throughout the calendar year.

Enlistments of college students who have not passed their 18th birthday will be accepted in the present V-1 program until March 15, 1943, only. Thereafter college students are eligible for selection for the new Navy college training program only through the regular procedures established for all other applicants.

3. STATUS OF NAVAL ROTC UNITS

Naval ROTC units will be continued and Naval ROTC students will be selected at the end of the first two semesters, from students inducted in the new program. The present Naval ROTC curriculum will be modified so that all professional subjects will be given subsequent to the first two semesters. All Naval ROTC students inducted in the Naval reserve will be placed on active duty.

4. PRESENT PROBATIONARY COMMISSIONED STUDENTS

At a date to be announced shortly, students now holding probationary commissions, on inactive duty in a deferred status, in the United States Naval Reserve will be permitted to resign and accept assignment to the college training program as apprentice seamen on active duty. At the satisfactory completion of their prescribed professional education they will be again commissioned in the USNR.

5. SELECTION OF TRAINEES

(*a*). High-school graduates or students having equivalent formal education who will have attained their 17th but not their 20th birthday at the time of enlistment or induction will be eligible for this program. Enlisted or inducted men with the above educational qualifications, who will have reached their 17th but not their 23d birthday, and who are recommended by their commanding officer, are eligible to apply for this program.

(*b*). Students will be selected normally during the senior year in high school on the basis of their officerlike qualifications, including appearance, physical fitness, high-school scholarship records. No applicants will be considered unless they are organically sound, without physical disabilities, have 18/20 vision, and evidence potential officer qualifications. Candidates who cannot meet these requirements are advised not to apply.

(*c*). Procedures for the selection of students, in conformity with the President's executive order on man power, dated December 5, 1942, are being prepared by the Bureau of Naval Personnel. Information covering these procedures will be made available in the future.

(*d*). Successful candidates will be permitted to indicate their preference as to colleges to which they wish to be assigned, and these preferences will be respected insofar as possible, within geographical limits and student availability within the area. No guarantees, however, can be made that a student's request for a given institution will be granted.

(*e*). Students will be permitted to express preliminary choice of the branch of service including the Marine Corps and Coast Guard at the time of assignment to the Navy college program, but this choice will not be binding. Final assignment will be based upon demonstrated ability and counseling during the first two semesters.

(*f*). The various geographical areas of the country will be assigned quotas on the basis of population.

(*g*). Men assigned to this program may be transferred at their own request to class V-5 at any time if otherwise qualified. Men in class V-5 may be transferred as needed to specialized aviation cadet training at any time during their year of training under this program.

6. ARRANGEMENTS WITH THE COLLEGES

(*a*). Contracts with the institutions will provide for training, housing, feeding, and medical service.

The contract with the institution will insure a definite minimum number of men.

Students may or may not be housed in groups, depending upon local conditions. It is the responsibility of the institution to see that satisfactory feeding and housing are maintained. The institution's contract will cover the cost of the same.

(*b*). The Navy will furnish each institution at least one officer for purposes of naval administration.

General instructions for discipline and routine will be issued by the Bureau of Naval Personnel, in order that procedures may be standardized insofar as local conditions will permit.

(*c*). A co-operating institution will be required to accept men ordered to it for training. At the same time each institution will be expected to maintain high standards of selectivity in examinations, instructions, and so forth, and to recommend transfer to other duty of students who fail to meet these standards.

7. CURRICULA AND REQUIREMENTS FOR TRAINING

The Navy will prescribe the curricula which are necessary to insure production of officer material for the various branches of Naval service, including aviation cadets, engineer and deck officers, engineer specialists, medical and dental officers, supply corps officers, and chaplains. Curricula will vary in length, depending on training requirements. With the exception of medical and dental officers, engineering specialists, and chaplains, the length will be from two to six equivalent semesters.

(*a*). Courses for the first two 16-week terms or the equivalent will be similar for all students and will emphasize fundamental college work in mathematics, science, English, history, drawing, and physical training. All students inducted in the new Navy college training program will receive instruction in naval organization and general naval orientation. The amount of time devoted to this work will not exceed three class hours per week during the first two semesters.

Outlines of all curricula will be prepared by the Bureau of Naval Personnel, with such assistance as may be required from representative educators or educational societies.

(*b*). If the college is satisfied that the student has covered adequately any of the subjects included in the curricula, proper substitutes will be permitted.

(*c*). The Navy will give achievement examinations at the end of the first two terms. The result of these examinations will be used in determining further assignments.

(*d*). Any student who fails to maintain a satisfactory standing in the course will be dropped from college and transferred to other naval duty.

8. ASSIGNMENT AT COMPLETION OF TRAINING

Upon satisfactory completion of college training all students will be assigned to appriate specialized training in the Navy, Marine Corps, or Coast Guard. Selection for this training will be based on student preference, counseling, and acceptance by the service concerned. If found qualified upon completion of this training, the students will be commissioned in the appropriate reserve.

Resolutions on Man Power Issued by Engineering Committee

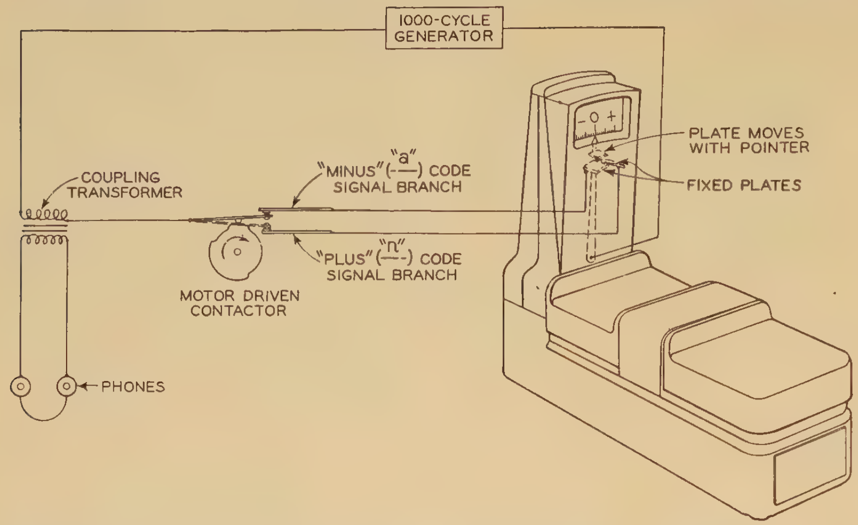
The consultative committee on engineering for the professional and technical division of the War Manpower Commission, under the chairmanship of R. E. Doherty (F '39), president of Carnegie Institute of Technology, Pittsburgh, Pa., recently passed two resolutions concerning engineering man power. The first is:

The committee recommends that the War Manpower Commission undertake immediately, with the co-operation of the War Production Board, a factual survey of shortages of professional engineering man power in war industries, and surpluses wherever they may exist, in order to establish a rational basis for planning a program for the most effective training and use of the limited engineering manpower.

The committee's second resolution follows.

Recognizing the necessity for a continuing flow of professionally trained men for war industries, especially for urgent developmental work in improving the quality and production of actual weapons and materials of warfare, this consultative committee on engineering for the professional and technical division of the War Manpower Commission, respectfully recommends that the chairman of the War Manpower Commission immediately take the necessary steps in order to provide temporary deferment from military service for those undergraduates in recognized engineering schools who are subject to Selective Service. Such deferment is necessary pending a more thorough study

"Audio Scale" May Open War Work to Blind



The radio-beam scale, developed by the Toledo (Ohio) Scale Company, is expected to make it possible for the blind to play a part in war production by weighing certain materials such as powder for fuses, mica for radio mechanisms, and buttons for uniforms accurately and rapidly. Alternating current of 1,000 cycles flows in tuneable double-branch circuit, with an earphone coupling transformer common to both branches. A motor-driven contactor switches the current alternately to the two branches so that the intermeshed "a" and "n" pulses are applied respectively to the minus and plus fixed plates of the scale indicator balancing condenser. At the desired weight, both signals are heard synchronized.

of the requirements of engineering man power both by war industries and the Armed Forces.

This recommendation confirms and re-emphasizes the resolutions made by the recent annual meetings of the American Society of Mechanical Engineers, the American Institute of Chemical Engineers, the Society for the Promotion of Engineering Education, and others, looking to the deferment of those young men who are already in engineering training and are maintaining satisfactory academic records. This is not a recommendation for class deferment but is a recognition of a temporary but critical phase of the man-power situation which requires prompt and decisive action to prevent serious crippling of the war program.

John C. Parker (F '12), AIEE past president, is AIEE representative serving on this committee.

Specialists Needed to Administer Controlled-Materials Plan

The United States Civil Service Commission recently began a nation-wide search for production specialists to administer the War Production Board's new Controlled-Materials Plan. The plan, designed to balance essential industrial production against available stockpiles of critical materials, will go into operation in 1943 (*EE, Dec. '42, pp. 630–1*).

Many hundreds of production and materials-control specialists whose experience demonstrates their ability to co-ordinate and schedule industrial production in certain fields are being called upon to make their services available wherever possible, according to the Commission's announcement. Applications, however, are not sought from persons already using their highest skills in war work.

Urgently needed are persons with industrial or engineering experience in the fields of copper, aluminum, carbon steel, and alloy steel. Also highly important to this program are those with such experience in

1. Machine tool and machinery production.
2. Electrical and communications equipment.
3. Transportation equipment, such as aircraft, ships, and railroad motive power, and rolling stock.
4. Engineering materials such as plastics, rubber, and construction materials.

Under the plan, specialists will be appointed to WPB, Navy, and other war agencies to assist in the allotment of critical materials going into military and essential civilian supplies and equipment. They will determine the material needs of manufacturers, schedule production, and follow up production to insure the flow of critical materials according to plan.

Production and materials-control specialist. Head specialists will receive $6,500 a year; others $4,600 and $5,600 a year. Many positions, however, must be filled at salaries ranging from $2,000 to $3,800 a year. Jobs are located in Washington, D. C., and throughout the nation. Persons interested may obtain the Commission's announcement 279 concerning the jobs from local representatives at first- and second-class post offices, or from the United States Civil Service Commission, Washington, D. C. No written test will be given, and there is no maximum age limit. Applications with the title "Production Control Specialist," or "Materials Control Specialist" inserted, must be filed with the Commission's Washington office and will be accepted until the needs of the service have been met. War man-power restrictions on Federal appointment of persons engaged in certain critical occupations in specified areas are contained in form 3989 posted in first- and second-class post offices.

Publications Tell How to Conserve Critical Materials

Within the last few months many articles pointing to ways of conserving critical materials have appeared in *Electrical Engineering* and other publications. The subcommittee on conservation of materials of the AIEE committee on co-operation with war agencies has prepared a list of articles of this kind which have come to its attention and which it is believed will be of general interest to members of the Institute.

AIEE PAPERS

Distribution Substations and Wartime Necessities, **F. C. Poage, M. W. Reid.** AIEE *Transactions*, volume, 61, 1942, March section, pages 117–22.

Electric-Power Distribution Systems in Wartime **Philip Sporn.** AIEE *Transactions*, volume 61, 1942, March section, pages 105–6.

Emergency Overloads for Oil-Insulated Transformers, **F. J. Vogel, T. K. Sloat.** AIEE *Transactions*, volume 61, 1942, September section, pages 669–73.

Interim Report on Guides for Overloading Transformers and Voltage Regulators, **AIEE transformer subcommittee.** AIEE *Transactions*, volume 61, 1942, September section, pages 692–4.

Load Ratings of Cable—II, **Herman Halperin.** AIEE *Transactions*, volume 61, 1942, pages 930–42.

Overhead Distribution Systems in Wartime, **Harold Cole.** AIEE *Transactions*, volume 61, 1942, March section, pages 123–6.

Power Supply to Distribution Substations in Wartime, **H. P. St. Clair.** AIEE *Transactions*, volume 61, 1942, March section, pages 112–7.

Standardized Load-Center Unit Substations for Low-Voltage A-C Systems, **E. M. Hunter, J. C. Page.** AIEE *Transactions*, volume 61, 1942, July section, pages 519–25.

The Fundamentals of Industrial Distribution Systems, **D. L. Beeman, R. H. Kaufmann.** AIEE *Transactions*, volume 61, 1942, May section, pages 272–9.

Underground Distribution Systems in Wartime, **L. R. Gaty.** AIEE *Transactions*, volume 61, 1942, March section, pages 107–12.

OTHER PUBLICATIONS

General

Industrial Mobilization, **R. P. Patterson.** *Army Ordnance*, March–April 1942.

Material Standards in National Preparedness, **Colonel W. C. Young.** ASTM, August 1940.

Material Substitution and Supply List. Office of War Information, War Production Board. WPB 2112. (Lists over 500 materials ranked on basis of necessity and availability. List is revised periodically.)

Strategic Materials, **Captain G. K. Hess.** *Army Ordnance*, July–August 1940.

World Minerals and World Politics, **C. K. Leith.** Whittlesey House.

Increasing Extent of Use of What We Have

Assisting the Customer to Make Maximum Use of His Existing Electrical Facilities, **E. A. Brand.** Edison Electric Institute *Bulletin*, April 1942.

Breaker and Switch Contacts Resurfaced With Silver Alloy. *Electrical World*, October 17, 1942.

Conservation of Linemen's Rubber Protective Equipment. **Roy M. Godwin.** Edison Electric Institute *Bulletin*, July 1942.

The Dual Rating of Electrical Apparatus, **P. L. Alger.** *Electrical Engineering*, December 1941, pages 569–71.

How Electric Utilities Are Solving Operating Problems Arising Out of the War. (A symposium of 142 cases.) *Electrical World*, May 30, 1942.

May Copper Work Harder, **Lee F. Adams.** *Electrical West*, November 1942.

Overmotoring—Almost a Crime, **L. A. Umansky.** *Blast Furnace and Steel Plant.* September 1942.

Results of Emergency Overload Tests on 24-Kv, 3-Conductor Paper and Lead Cables, **G. B. McCabe, Joseph Sticher.** Edison Electric Institute *Bulletin.* November–December 1942.

Supplying Kilovar Loads for War Conservation and Economy, **M. C. Miller.** Edison Electric Institute *Bulletin*, October 1942.

Utilizing Full Transformer Capacity Safely. *Westinghouse Engineer*, August 1942.

Vital Materials Conserved by Fusing and Banking of Transformers, **M. M. Levy.** *Electric Light and Power*, June 1942.

Making Minimum Use of Critical Materials

American Society For Testing Materials Standards and Emergency Standards.

Ceramic Insulating Materials, **Hans Thurnauer.** *Electrical Engineering*, volume 59, November 1940, pages 451–9.

Conservation of Materials for Defense Wiring, **H. R. Stevenson.** (*CNX* Wiring System.) Edison Electric Institute *Bulletin*, November 1941.

Critical Materials—Their Conservation by Use of Alternates, **John Horn.** *General Electric Review*, July 1942.

Doing a Bigger Job With Less (substitute materials.) **Alvin von Auw.** *Bell Telephone Magazine*, August 1942.

Evaluate Steel Pipe as A-C Conductor, **Stanley C. Killian.** *Electrical World*, April 18, 1942.

Forest Products Handbook. Forest Products Laboratory. Technique of Plywood, **Charles B. Norris.** Pitman Publishing Corporation.

Galvanized Steel as a Power Conductor, **Frederick M. Crapo.** *Electrical World*, September 19, 1942.

Handbook Dow Metal Magnesium Alloys. Dow Chemical Company.

Material Conservation (substitute materials), **Fredric Luther.** *Wire and Cable Products*. October 1942.

Metal Shortages and Their Effect on Line Hardware, **Earl H. Kendall.** Edison Electric Institute *Bulletin*, November 1941.

Modern Plywood, **I. F. Lancks, Thomas D. Terry.** Pitman Publishing Corporation.

National Emergency Steels. *Metal Progress*, October 1942.

Opportunities for Conservation of Critical Materials in Victory House Wiring and Industry, **J. F. Porter, Jr.** Edison Electric Institute *Bulletin*, April 1942.

Plastics in 1940. *Fortune*, October 1940. What Man Has Joined Together. *Fortune*, March 1936.

Proposed Tentative Alternative Bronzes. Society of Automotive Engineers *Journal*, June 1942.

Smaller Transformers by Forced Cooling, **W. G. James.** *Westinghouse Engineer*, August 1942.

Solders With Less Tin for Wipes and Joints. (Describes "victory" cable joint and summarizes experiences with low-tin wiping solders.) *Electrical World*, August 22, 1942.

Substitutions for Critical Materials. *Electrical Engineering*, volume 61, June 1942, pages 317–20.

Substitution and Conservation of Materials, **E. H. Tovee.** *The Canadian Purchaser*, December 1942.

Supplement to the 1940 National Electrical Code (Interim Amendments effective only during the war emergency).

Synthetic Fibres—The Growth of Rayon and the Rapid Rise of New Synthetics. *Rayon Textile Monthly*, May 1941, June 1941.

"Victory Joints" Conserve Tin (new technique for wiping joints in lead covered cables), **Fred C. Buerk**, *Telephone Engineer*, April 15, 1942.

Wartime Substitutions and Changes. (Specific instances of how familiar materials and methods are replaced with different things and ways.) *Electrical World*, October 17, 1942.

Getting Materials Back Into Circulation

Easing Your Priority Problems With Reclamation, **K. C. Campbell.** Edison Electric Institute *Bulletin*, August 1941.

Erie Shows the Way in Salvage Campaign. *Purchasing*, February 1942.

Getting in the Scrap Proves to be a Continuous Process *Electric Light and Power*, August 1942.

"Gold" in the Scrap Pile, **Ray Schmidt.** *Factory Management and Maintenance*, September 1942.

Machines Must Work for War—or Scrap! (A systematic survey to uncover scrap), **E. B. Robinson.** *Power*, October 1942.

Salvage From a Producer's Viewpoint, **C. R. Stevans.** *Steel*, October 12, 1942.

Salvage and Scrap Material Manual for the Utilities. Industrial Salvage Section, conservation division, War Production Board.

Sectional Conference on Reclamation and Salvage. Edison Electric Institute *Bulletin*, February 1942, March 1942.

We're in the Scrap. *Contact*, October 1942.

Problems for War and Peace Discussed by B. W. Clark

"We are fighting for peace and hoping that with peace will come the beginning of a new and better world," said B. W. Clark, vice-president of Westinghouse Electric and Manufacturing Company, in a recent address, "Problems Facing Industry for War and Peace," which he presented to the Producers' Council, November 17, 1942.

Important aspects of the peace, according to Mr. Clark, are:

"1. While a period of readjustment to peacetime conditions must take place, it should be no more difficult than our recent adjustment to wartime conditions.

"2. The people of a war-torn world, especially of the United States, are not going to give in to such a depression as we could visualize. They are fighting for freedom, security, and the good things of life, and they are going to have them.

"3. To the extent that industry is farseeing, courageous, and able, there should be a return to free enterprise . . .

"4. The pent up demand for the goods of peace will be unprecedented. These goods are wearing out, and they are becoming obsolete. More new families have been launched in the last two years than in any similar period. They'll want homes—modern homes—equipped with modern conveniences.

"5. The means of purchasing will be there—in cash, bonds, and credit. The people can't spend their money now, and the consequent purchasing power for the future will be vast. The accumulations of debt to cover house buildings and repair, automobiles, refrigerators, and so forth—billions of dollars—are almost liquidated. The credits will be ready to finance new peacetime business."

Problems in future industrial activities will entail standards of building, now developed in a mass of individual codes which tend to increase building costs, slow construction, and confuse everyone concerned. In the interest of simplification, speed, and saving of critical materials, Federal restrictions and uniform standards have superseded these individual codes. "Every branch of this industry ought now, I believe,' commented Mr. Clark, "to be considering sane standards of safety and permanence, and should be working towards sane and uniform codes that will enforce sound construction for each type of building, with due regard for the peculiar requirements of location, in the interest of lower costs, better understanding, and businesslike administration."

Another problem is product research and design for the future. A long vista of improvement in design, manufacture, performance, and cost of homes, automobiles, appliances, and new facilities for making life simpler and easier following the war is visualized for the public by advertisers and writers of postwar predictions. Expansion in light metals, alloys, plastics, wood products, cement and concrete, and motor fuels points to the probability of a peacetime revolution. Mr. Clark warned against too rapid and too radical change in design.

Mr. Clark praised industry's response to the problems arising from war, a miracle wrought out of vast expansion of industrial equipment, quick adaptation to the requirements of new war machines, and technical advances.

"The figure of $13^1/_2$ billion dollars for 1942 construction speaks for itself. Doubled in dollars in two years, largely of the cheapest construction available for the given job, it is 15 per cent greater in dollars than the 1929 peak; and remember the 1929 peak was in high-cost office buildings, apartments, hotels, and so forth. The peak was reached after a gradual six-year climb," said Mr. Clark. He reminded members of the Producers' Council that experts expect a decline in new buildings to about eight billion dollars in 1943, with a further decline in later war years.

Mr. Clark quoted a War Production Board release to confirm his contention that the important business of repair and maintenance should be continued throughout war years. He predicted an increase of the problems of material procurement, man power, and transportation, the probability of discouraging news from the fronts, and the possibility of attack, but he also stated that industry was now able and determined to cope with any of these problems.

Electric Gauge Measures Thickness of Plating of Machine Parts

Portable electric gauges, which check to the thousandth of an inch the thickness of surface coatings of precision-machined plane and tank parts, without marring the parts, are being used in war plants to save time and materials, according to H. P. Kuehni, gauge expert of the General Electric Company. The lead-bronze, copper, silver, and heavy babbit linings on steel bearings and the chrome, nickel, and cadmium plating on other steel parts prevent corrosion and increase wearing qualities, and they must be accurate to a tiny fraction of an inch.

The main part of the gauge is a seven-pound portable indicating unit with a dial

marked in thousandths of an inch. A small cylindrical gauge head containing an electromagnet is connected to the indicating unit by a lightweight cable. The instrument is plugged into an ordinary a-c outlet.

When placed against a surface, the gauge head can measure the thickness of any nonmagnetic layer up to 0.3 inch thick and backed by steel. The head sets up electric currents in the instrument which vary in intensity with different layer thicknesses. By measuring the currents, therefore, the instrument can indicate the exact thickness on a dial large enough to be read at a glance at production-line speed.

Tungsten Production Increased by American Republics

Argentina is expected to increase its annual production of tungsten to about 3,000 tons, in order to fulfill its agreement signed in November 1941, to sell its exportable tungsten to the United States. Argentina's tungsten production in 1938 was approximately 2,000 tons, at that time about 3.5 per cent of the world's production. Bolivia, another chief producer of tungsten, signed a similar agreement with the United States.

Some tungsten is also produced in Peru, Mexico, Brazil, and Chile, and these American republics are increasing their production also to aid the United Nations war effort.

Formerly about 10 per cent of the world's tungsten (in addition to Argentina's share) came from the other Americas. But this proportion may have been changed in view of the necessity of developing new sources of supply with the closing of former sources in China and elsewhere.

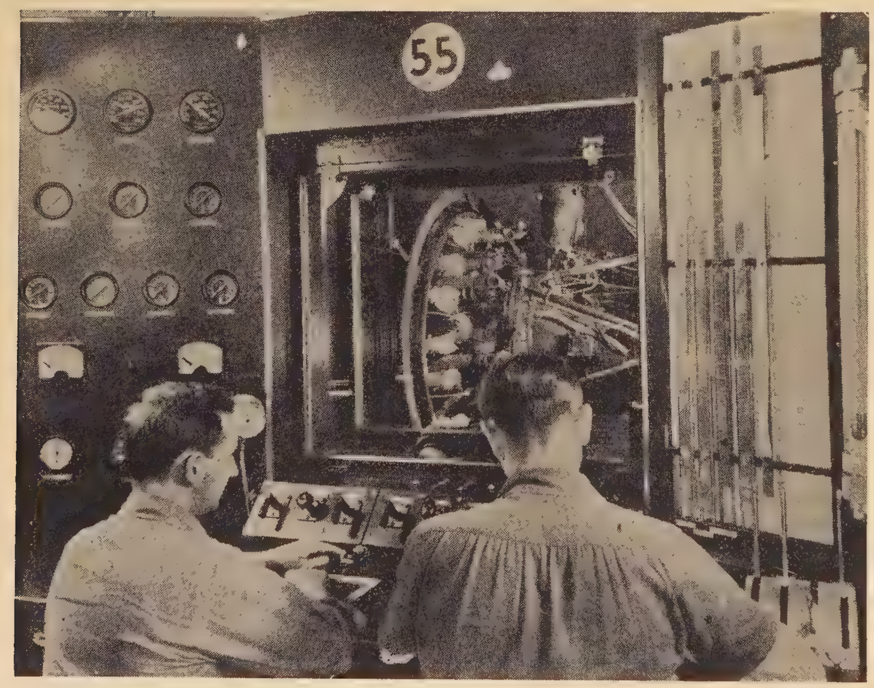
Articles on Aircraft Instruments Available

A series of articles on the repair and upkeep of aircraft instruments, which appeared in the *Horological Journal* of London, England, recently, is being made available by Henry Paulson and Company to those in the United States who are interested in the subject. This company has offered to reproduce these articles for distribution to interested AIEE members. The articles reflect British experience in maintenance of aircraft instruments in combat service.

The series covers the following subjects: Fuel pressure gauges, oil pressure gauges, pressure-gauge calibrator, precision measuring, rate-of-climb indicator, altitude recorder, air-speed indicator, compass, repair of jewels and pivots in instruments, gyroscopic instruments, timing indicator, directional gyro, Sperry horizon, gyropilot, how the gyropilot operates, bank and climb gyro, how the gyropilot is used. Members interested in securing any of these articles should address their inquiries directly to Henry Paulson and Company, 37 South Wabash Avenue, Chicago, Ill.

New Rubber Plant. An annual production of more than 875,000 tons of synthetic rubber will be the quota for a new large government-financed plant to be located in Kentucky. Production operations on this plant have just begun, reports John L. Collyer, president of the B. F. Goodrich Company, Akron, Ohio. The plant ultimately will utilize butadiene made from alcohol and very soon will be producing general-purpose synthetic rubber for the war program.

Test Engines Produce Electricity



Operators in this soundproof booth are checking the performance of new airplane engines which are producing electricity during their test runs by being connected to generators instead of propellers. The equipment shown in the picture, developed by engineers of Pratt and Whitney Aircraft and General Electric Company, records readings of the engine's performance, transmitted along lines run from the engine under test to the dials and indicators. This power-recovery system has been installed in a number of engine factories throughout the United States (*EE Sept. '42, p. 492*).

JOINT ACTIVITIES

ASA Holds Annual Meeting; Elects Officers

The important role played by standards in the nation's war program was the principal theme of the annual meeting of the American Standards Association, held December 11, 1942, at the Hotel Astor, New York, N. Y., R. E. Zimmerman, ASA president, on the association's work during the past year and Joseph L. Weiner, deputy director of the War Production Board Office of Civilian Supply, who was guest speaker at the meeting, explained how the Government's policy of concentration of production is being followed, why it was adopted, and how it is likely to affect civilian production (*EE, Sept. '42, p. 489*).

Mr. Zimmerman in his report of ASA work said, "The launching of a great coordinated national effort was destined to call upon standards in proportion to the enormity of the task ahead. At no other time in its existence had this organization been confronted with such opportunities for service nor has it faced such responsibilities.

"An ever increasing regard for standards has been developing in Government agencies and in business circles. In a recent talk, a high-ranking official told us that one of the major difficulties which the American army has been encountering abroad is the lack of thoroughly standardized parts for repair work. There has been the further complication of coordination with the British and our other allies on the dovetailing of supplies."

Among standards to be issued in cooperation with the nation's war program by the ASA, Mr. Zimmerman listed those for safety shoes for both men and women which will save valuable war material and at the same time protect workers against

injuries; a standard for the protective lighting of industrial properties, which will aid in safeguarding factories from theft, sabotage, and subversive activities of all kinds; a comprehensive program of standards for materials and parts for military radio which are expected for the first time to unify the requirements of the Army, Navy, prime contractors, and subcontractors.

Mr. Zimmerman pointed out further that "a drastic simplification program for repair parts for civilian radio is also being started. This will insure the 'home' radios of our country being kept in good working order. Features of construction, definitions of quality and operating performance, set up under this program will enable Office of Price Administration satisfactorily to relate quality to price in future price orders."

In addition to specific work carried out by the ASA to assist in war production, Mr. Zimmerman stated that "much of the peacetime work of the association was immediately available for the war effort, for example, the more than 80 mechanical standards for parts, tools, bolts, screws, bearings, drawings were ready for instant use. The 70 safety standards for the protection of workers from industrial accidents, the many electrical standards for motors, wires and cables, insulators, switchgear, and so forth, were available at once for Government purchasing and for arrangements with subcontractors."

In another field the association has been able to assist the Government in setting up its safety program in industry by supplying safety standards to arsenals, companies filling Government orders, and government departments. At the request of the Committee on Conservation of Manpower, it printed a special group of safety standards and made them available, at cost, to students in Government supervised safety engineering courses.

Mr. Zimmerman dwelt briefly on new ASA memberships during the year. Fifty new companies joined during the summer months. Four new national groups affiliated during the year:

Metal Cutting Tool Institute; Timber Engineering Company (a subsidiary of the National Lumber Manufacturers Association); Textile Color Card Association; Committee on Consumer Relations in Advertising.

"In another direction," said Mr. Zimmerman, "it is gratifying to be able to announce that means have been found whereby the ASA is undertaking an extensive program of co-operation on standardization work with the other American countries" (see item this page).

In his address at the annual meeting, Mr. Weiner pointed out that preliminary surveys of industries which seem to be capable of contributing to the war program if they are concentrated, are now being concluded. He went on to say, "It is now estimated that only $1^1/_2$ per cent of the total steel expected to be produced in 1943 will go into consumer products. Nearly all of that will be required for the maintenance of houses and durable goods already produced and in use. Similar curtailments are necessary in the usage of other metals such as copper, aluminum, and so forth. Concentration may be necessary because the essential civilian supply is so small a proportion of the capacity of an industry that if the production were shared out among all the plants within the industry according to their past business, none could be kept going. In these circumstances essential civilian supplies can be maintained only by the concentration of their production in a few plants."

ASA officers for 1942–43 were elected at the meeting. They are:

President: R. E. Zimmerman, vice-president United States Steel Corporation (re-elected to serve a third term).

Vice-president: George S. Case, chairman of the board, Lamson and Sessions Company.

Chairman, Standards Council: H. S. Osborne (F '21), American Telephone and Telegraph Company, New York, N. Y. (re-elected).

Vice-chairman: E. C. Crittenden (M '22), National Bureau of Standards, Washington, D. C.

The following five organizations were elected to fill vacancies occurring on the board of directors:

1. American Petroleum Institute.
2. American Gas Association.
3. Fire Protection Group.
4. Association of American Railroads.
5. American Institute of Electrical Engineers.

ASA Establishes Inter-American Program

It is expected that trade and industrial development of the Americas will be furthered by a program of inter-American co-operation on industrial and engineering standards which was launched recently by the American Standards Association, New York, N. Y.

In the new program the ASA will exchange technical data in the development and use of standards with the other American republics, give them information on the standardization work being done in the United States, and provide them with Spanish and Portuguese translations of standards which would be especially valuable in developing their industry. It is hoped that through this program a thorough exchange of technical information within the Western Hemisphere will result.

Cyrus T. Brady, Jr., engineer and sales executive of the United States Steel Export Company, has been granted a year's leave of absence to act as field representative on this project of the ASA. Members of the ASA advisory committee which has been appointed to serve as a guidance group under the chairmanship of R. E. Zimmerman, president of the ASA and vice-president of the United States Steel Corporation, are as follows:

Lyman J. Briggs, director, National Bureau of Standards; E. F. Callahan, vice-president, International General Electric Company; Alexander V. Dye, economic consultant, National Foreign Trade Council; H. Greenwood, vice-president, United States Steel Export Company; T. W. Howard, department of manufacture, United States Chamber of Commerce; C. L. Warwick, secretary-treasurer, American Society for Testing Materials; John W. White (A '29), vice-president, Westinghouse Electric International Company; Carroll L. Wilson, director, Bureau of Foreign and Domestic Commerce; J. T. Wilson, president, Export Managers Club.

Latin American countries have already shown interest in North American standards and have asked the ASA to supply them with further information. National standardizing bodies are already in operation in Argentina, Brazil, and Uruguay, and in other Latin American countries government departments and engineering societies are working on standardization. Furthermore there is a South American committee of which the function is to promote work on standards in the ten South American republics.

United Engineering Trustees, Inc. Elects Officers; Issues Report

At the annual meeting of the United Engineering Trustees, Inc., held October 22, 1942, the following officers for the year 1942–43 were elected: *president*, Albert Roberts (re-elected); *first vice-president*, F. Malcolm Farmer (F '13); *second vice-president*, Arthur S. Tuttle; *treasurer*, Arthur S. Tuttle (re-elected); *assistant treasurer*, W.D.B. Motter, Jr. (re-elected); *secretary* and *general manager*, John H. R. Arms (re-elected). The executive committee consists of the president, the two vice-presidents, J. P. H. Perry, W. D. B. Motter, Jr., and Walter Kidde.

Members of the board of trustees of UET for 1942–43 are:

Terms expiring October 1943
A. S. Tuttle, ASCE
Albert Roberts, AIME
Walter Kidde, ASME
C. E. Stephens, AIEE

Terms expiring October 1944
C. E. Trout, ASCE
W. D. B. Motter, Jr., AIME
K. H. Condit, ASME
E. S. Lee, AIEE

Terms expiring October 1945
A. L. Queneau, AIME
F. M. Farmer, AIEE

Terms expiring October 1946
J. P. H. Perry, ASCE
H. A. Lardner, ASME

Members of the finance committee are:

Walter Kidde, *chairman*	H. A. Lardner
Arthur S. Tuttle	C. E. Stephens
A. L. Queneau	Albert Roberts, *ex officio*

Members of the real-estate committee are:

Kenneth H. Condit	A. L. Queneau
E. S. Lee	C. E. Trout
J. P. H. Perry	Albert Roberts, *ex officio*

United Engineering Trustees, Inc., was organized in 1904 to manage property and funds held jointly by the four national Founder Societies: American Society of Civil Engineers, American Institute of Mining and Metallurgy, American Society of Mechanical Engineers, and American Institute of Electrical Engineers. The UET maintains two departments, the Engineer-

ing Societies Library and The Engineering Foundation, reports of which appear elsewhere in this issue. The corporation (UET, Inc.) manages the Engineering Societies Building and all trust funds placed with UET, Inc.

ANNUAL REPORT

The annual report of UET, Inc., for the year ending September 30, 1942, has been submitted to the AIEE and the other participating societies by Albert Roberts, president. Essential substance of the report follows.

The entry of the United States into the war shortly after the beginning of the last fiscal year has created additional problems and difficulties in the conduct of the affairs of the corporation.

A considerable program of renovation of the Engineering Societies Building was under way, supplies for which became subject to war priorities, and prices rose on those materials which were obtainable. However, the work was sufficiently advanced so that, despite some delay, it was completed during the year at a moderate increase in cost over the original appropriations. Results have been very gratifying both to the occupants and to the board of trustees of UET.

The operating financial position was adversely affected, in that labor costs and operating material costs have risen and income from rental of halls and auditorium has decreased, as these have been used largely for educational meetings attended by young men, many of whom are now engaged in the war effort. These adverse effects will be greater in the ensuing fiscal year.

Financial conditions and security prices suffered further dislocations during the year, and new problems have arisen. Nevertheless, UET security holdings, under the management of the finance committee, with the co-operation of our financial advisers, have improved in quality. As in the past year, all securities are held by the Chemical Bank and Trust Company as custodian.

The depreciation and renewal fund at the end of the year stood at $434,239.48, after receipt of the appropriation of $20,000 from operations, as for some years past, and the income from its investments, less outlays for renovation and improvement made during the year, totaling $41,496.75.

The corporation acts as treasurer for the Engineers' Council for Professional Development, and is custodian of the relief funds of Engineering Societies Personnel Service, Inc., and funds of the John Fritz Medal Board of Award and of the Daniel Guggenheim Medal Board of Award. It is also custodian of contributions from outside organizations aiding researches by the Engineering Foundation.

During the summer of 1941 renovation had been started in various parts of the Engineering Societies Building which after 35 years of service to the societies required repairs or renewal. This work was retarded by the increasing difficulty in obtaining materials, and completion ran well into 1942. One of the most striking improvements was the elimination of the false skylight illumination in the auditorium and the substitution of a safer means of providing more pleasing and more even illumination of adequate intensity.

Additional expenditures beyond the budget were incurred during the year in the amount of approximately $2,000 for the purchase of war-damage insurance on the building and for fire-fighting and safety equipment which under civilian defense laws became mandatory. In addition, maintenance supplies were purchased ahead as available, which increased the year's expenditures but which should reflect a corresponding decrease in the coming year.

On the income side, revenue from the meeting halls fell about $2,000 short of expectations owing to cancellation of scheduled meetings and classes due to war conditions. It is heartily urged that the societies utilize their building to the maximum of their requirements, and thus augment UET income.

Insurance inspectors report the building is in excellent physical condition. The corporation was fortunate in having the fire-insurance rate on the building further reduced, the resulting rates being the lowest given to any property of its class. Fire, extended coverage, liability and compensation insurance are carried, to which was added, on July 1, war-damage insurance.

All available space in the building is occupied by the Founder Societies and associates.

The 1941 annual report (*EE, Jan. '42, pp. 56–7*) recorded that the opinions of architects obtained at that time made it evident that the cost of major changes in the building to make it more nearly meet the present needs would not be justified by the possible benefits.

In pursuit of this general subject an extensive review of the condition and value of the building and property in relation to the depreciation and renewal fund has recently been concluded and a report has been transmitted to the Founder Societies.

The time will come when the war and ensuing readjustments being over, participating societies may feel warranted in replacing the present quarters with new quarters. The roster of the four societies includes many, if not the majority, of those largely responsible for the creation and operation of all the basic facilities of modern life, from the production of the necessary raw materials to final utilization and operation in their finished form. With this talent available it would seem that only organization is needed in order to achieve this end.

Engineering Foundation Report Issued; Officers Elected

The following officers for the year 1942–43 were elected at the recent annual meeting of The Engineering Foundation, joint research agency of the Founder Societies: *chairman*, A. L. Queneau; *vice-chairman*, Kenneth H. Condit; *director*, Edwin H. Colpitts (F '12) (re-elected); and *secretary*, John H. R. Arms. Members of the executive committee, in addition to the chairman, vice-chairman, and secretary of the Foundation are: J. P. H. Perry, W. I. Slichter (F '12), and C. E. Stephens (M '22).

Members of the Foundation board for 1942–43, with expiration dates of terms, are:

Trustees elected by the board of trustees of UET, Inc.

K. H. Condit, ASME, 1943
C. E. Stephens, AIEE, 1943
J. P. H. Perry, ASCE, 1944
A. L. Queneau, AIME, 1945

Ex officio, president, UET, Inc.

Albert Roberts

Members nominated by Founder Societies

J. D. Justin, ASCE, 1943
E. M. T. Ryder, ASCE, 1946
A. A. Potter, ASME, 1943
Edwards R. Fish, ASME, 1944
G. D. Barron, AIME, 1944
F. F. Colcord, AIME, 1946
F. M. Farmer, AIEE, 1943
W. I. Slichter, AIEE, 1944

Members-at-large

J. V. N. Dorr, AIME, 1943
R. H. Chambers, ASCE, 1943
O. E. Buckley, AIEE, 1946

Members of the research procedure committee are:

K. E. Condit, *chairman*, ASME
E. M. T. Ryder, ASCE
H. E. Wessman, ASCE
W. M. Peirce, AIME
C. L. W. Trinks, ASME
L. W. Chubb, AIEE

Chairman Queneau was appointed to represent the Foundation on the executive board of the National Research Council.

The personnel of other committees as appointed or reappointed at this meeting is as follows:

Iron Alloys Committee

George B. Waterhouse, *chairman and director*, professor of Metallurgy, Massachusetts Institute of Technology, Cambridge, Mass., AIME.

Lyman J. Briggs, director, National Bureau of Standards, represented by J. G. Thompson, senior metallurgist, National Bureau of Standards, Washington, D. C.

R. R. Sayers, director, United States Bureau of Mines represented by R. S. Dean, assistant director, United States Bureau of Mines, Washington, D. C.

James T. Mackenzie, chief metallurgist, American Cast Iron Pipe Company, Birmingham, Ala., American Foundrymen's Association.

John Johnston, director of research, United States Steel Corporation, Kearny, N. J. American Iron and Steel Institute.

James H. Critchett, vice-president, Union Carbide and Carbon Research Laboratories, Inc., New York, N. Y., American Electrochemical Society.

Bradley Stoughton, professor emeritus, Lehigh University, Bethlehem, Pa., American Society for Metals.

Jerome Strauss, vice-president, Vanadium Corporation of America, New York, N. Y., American Society for Testing Materials.

T. H. Wickenden, assistant manager, development and research, The International Nickel Company, Inc., New York, N. Y., Society of Automotive Engineers.

Wilfred Sykes, president, Inland Steel Company, Chicago, Ill. member-at-large.

Frank T. Sisco, *consultant*, assistant secretary, AIME, New York, N. Y.

R. E. Zimmerman, vice-president, United States Steel Corporation of Delaware, Pittsburgh, Pa.

William Spraragen, *executive secretary*, Welding Research Council, The Engineering Foundation, New York, N. Y.

Welding Research

Comfort A. Adams, *chairman*, consulting engineer, E. G. Budd Manufacturing Company, Philadelphia, Pa.

Harry C. Boardman, *vice-chairman*, director of research, Chicago Bridge and Iron Company, Chicago, Ill.

A. S. Albright, acting chief of research, Detroit (Mich.) Edison Company.

David Arnott, vice-president, American Bureau of Shipping, New York, N. Y.

Everett Chapman, president, Lukenweld, Inc., Coatesville, Pa.

O. U. Cook, assistant manager, department of metallurgy, inspection and research, Tennessee Coal, Iron and Railroad Company, Birmingham, Ala.

J. H. Critchett, vice-president, Union Carbide and Carbon Research Laboratories, Inc., New York, N. Y.

J. J. Crowe, assistant to vice-president and operating manager, Air Reduction Sales Company, New York, N. Y.

C. L. Eksergian, chief engineer, Budd Wheel Company, Detroit, Mich.

A. J. Ely, mechanical engineer, Standard Oil Development Company, Elizabeth, N. J.

F. H. Frankland, director of engineering, American Institute of Steel Construction, New York, N. Y.

T. S. Fuller, works laboratory, General Electric Company, Schenectady, N. Y.

Isaac Harter, vice-president, Babcock and Wilcox Company, New York, N. Y.

D. S. Jacobus, advisory engineer, Montclair, N. J.

G. F. Jenks, Taylor Winfield Corporation, Warren, Ohio.

Arthur E. Pew, vice-president, Sun Oil Company, Philadelphia, Pa.

A. C. Weigel, vice-president, Combustion Engineering Company, New York, N. Y.

Clyde Williams, National Defense Research Committee, Battelle Memorial Institute, Columbus, Ohio.

A. R. Wilson, engineer of bridges, Pennsylvania Railroad, Philadelphia, Pa.

Seventeen researches bearing on war work were endorsed by the board for support by grants during its fiscal year 1942–43. These include investigations in the fields of civil, mining and metallurgical, and mechanical and electrical engineering, covering various problems of soil mechanics and foundations, hydraulics, alloys of iron, critical pressure steam boilers, fluid meters, cold rolling steel, insulating oils and cable saturants, and welding. Professional development of the engineer also received the recognition of the board by a grant toward the work of the Engineers' Council for Professional Development.

ANNUAL REPORT

The salient points of the annual report of The Engineering Foundation as submitted by Chairman O. E. Buckley (F '29) to the AIEE and the other Founder societies follows.

The Engineering Foundation, established in 1914, completed its 28th fiscal year on September 30, 1942. The book value of the capital funds of the Foundation on September 30, 1942, was $952,000, a slight reduction from that of a year previous. The income has continued to suffer reduction due to lower prevailing interest rates. As a partial offset to this loss of income, it has been possible to reduce administrative and general expenses materially.

It has been the policy of the Foundation for many years to contribute to a considerable number of projects in diverse fields of engineering. This policy has been continued, but projects have been reconsidered with regard to their bearing on the war, and have been encouraged only in so far as they appear to contribute to the war effort. In several cases, grants which have been provided have not been utilized fully because of withdrawal of personnel to more direct war activities. It is expected that this trend will continue during the course of the war, and on that account it may be impracticable to make full use of the Foundation's income on projects helpful to the national cause. This is particularly the case in view of the Government's willingness to support research projects which can be demonstrated as important to the war effort.

During the year, work has progressed on 15 projects, comprising 21 separate problems. For the ensuing year, grants were recommended for the continuation of work on 11 problems and the initiation of 2 new projects.

Summaries of the research projects which were sponsored by the Foundation and with which the AIEE has been directly associated follow:

Stability of Impregnated-Paper Insulation. (Foundation grant, $1,000. Chairman, Doctor John B. Whitehead, Johns Hopkins University, Baltimore, Md.)

This research project has been supported by The Engineering Foundation for the past six years. No extension of support beyond the year 1941–42 has been received. During that year the feature of outstanding importance was the continuation of the study of the influence of paper density in impregnated-paper insulation for high-voltage service. These further studies have emphasized the results of studies in foregoing years, that the use of higher-density papers results in a shortening of life and lowering of dielectric strength in this type of insulation. This result has been unexpected by many cable manufacturers and will undoubtedly lead to modification and changes in the design of important types of high-voltage cables and capacitors.

Another important result has been the clarification of the open question of the influence of oil viscosity on impregnation, and life, and dielectric strength of this type of insulation. The less viscous oils have a markedly superior influence on life and dielectric strength.

The studies on the origin and progress of failure under high stress, utilizing an improved method for detecting the first presence of internal gaseous ionization, have been extended and a much clearer picture is now available of the origin and cause and process of failure.

Any report on this project would not be complete without expressing the opinion that Doctor Whitehead has done very important work in his studies of insulation and more particularly on impregnated-paper insulation. As the advisory committee has stated in its report, "The experimental studies have been conducted with a high degree of experimental skill and the results are characterized by accuracy and uniformity. While the program originally contemplated has been in large measure completed, certain of the results obtained, particularly those relating to paper density, high-stress internal ionization as the origin of failure, impregnation temperature versus dielectric strength and life, the limitations of the open tank in laboratory studies, all indicate the desirability that the work can be carried further."

It is certainly true that to a very high degree, Doctor Whitehead's work has stimulated research activities on the part of a number of workers in other organizations.

During the year in connection with this work the paper, "The Dielectric Strength and Life of Impregnated-Paper Insulation—III," by J. B. Whitehead (AIEE *Transactions*, volume 61, 1942, August section, pp. 618–22) was presented.

Insulating Oils and Cable Saturants. (Foundation grant, $1,500. Chairman, Herman Halperin, assistant equipment and research engineer, Commonwealth Edison Company, Chicago, Ill.)

The problem undertaken involved primarily the study of the electrical stability of electrical insulating oils under limited oxidation conditions. In this connection a new type of test has been developed. It is believed that it duplicates service conditions in oil-impregnated paper-insulated cables and in sealed transformers. In this test, definite and controlled amounts of oxygen are made available to the oil. These amounts vary from residual amounts, to amounts due to normal solubility of air in oil, and to larger amounts. Operating performance of oil-paper cables has, in certain cases, shown power-factor increases of the insulation which have been serious and impossible to explain, and it is believed that the test referred to will give important aid in the control of this problem. While electrical loss or power factor is not of prime importance for many types of oil-filled electrical equipment, it is the most sensitive known criterion for a stability test.

The work for the past fiscal year has included the following:

Tests on specially refined samples of oils supplied by the Gulf Research and Development Company and by the Shell Petroleum Corporation. These samples have been prepared to determine the effect of different refining procedures and the hydrocarbon constituents of the oils.

Tests on commercial insulating oils currently finding application in practice are made for purposes of correlation of the project's test results with results in service.

The characteristics of mineral oils, in general, are changed radically by the addition of small amounts of addition compounds. This procedure with respect to mineral oils is somewhat analogous to alloying for metals. For this purpose, the Gulf Research and Development Company has supplied a wide range of inhibitors and sulphur compounds of known structure.

The important results, from a practical point of view are as follows:

The degree and type of refining greatly

influences the electrical stability of the oils.

Certain addition compounds can very greatly influence the characteristics of an oil. It is believed that further improvement in the characteristics of electrical insulating oils will be obtained from this procedure. These addition compounds are added in amounts corresponding to a few hundredths or a few tenths of a per cent. In certain cases quite satisfactory results have been obtained using such compounds. However, it is rather difficult to obtain a compound to produce desirable characteristics for a wide range of service applications.

Welding Research Committee. (Foundation grant, $5,000. Chairman, Doctor Comfort A. Adams, E. G. Budd Manufacturing Company, Philadelphia, Pa.)

During the year 1941–42 the work of the Welding Research Committee has continued to be closely related to the war effort. Its activities are organized with the definite thought in mind of solving the many important welding problems that are raised in connection with manufacture and production for the armed services. Fortunately, the committee began to gear its efforts to national defense about two years ago, and the value of this head start is extremely important.

The fundamental research division, for example, realizing that it would be necessary to predict the weldability of any new steel, and to specify the exact procedure to follow in order to get the best results, outlined a comprehensive fundamental research program and by initiating such a program, in spite of serious financial obstacles, saved at least nine months of precious time.

The industrial research division has organized a number of new projects and extended its activities, especially in the field of aircraft welding. It has co-operated with, and assisted the National Advisory Committee for Aeronautics in the organization of numerous welding researches being carried out by that committee. It has also co-operated with the National Research Council and the National Defense Research Committee in furnishing information as to existing researches and the need for additional work. Several projects have been recommended through the Council and are being financed by the National Defense Research Committee. Close contacts have been maintained with the War and Navy Departments and other Government agencies interested in welding. The division's operations have been directed to problems directly related to war production.

The Foundation grant as in the past years was allocated to the fundamental research division and a brief reference to this division's work follows:

A comprehensive program on weldability under the auspices of the fundamental research division is well under way and nearing completion. The results of this research investigation will enable one to predict the weldability behavior of any new steel, and to indicate suitable procedures for welding any thickness of material under different climatic conditions. These investigations have been conducted at Lehigh University, Rensselaer Polytechnic Institute, Massachusetts Institute of Technology and Columbia University. The government, through the National Defense Research Committee, has appreciated the importance of this work in the war effort, and is financing the greater portion of it to the extent of some $29,000 a year. This sum is in addition to approximately $13,000 a year expended under the jurisdiction of the division.

A start has been made on studying the underlying phenomena of residual stresses and their behavior under service conditions. Preliminary pronouncements have been made in some special cases, as for example, what happens to residual stresses when plastic flow is possible. These experiments must be continued to cover more restrained conditions and suddenly applied loads.

The division continues to encourage research work in the different universities of this country. A great deal more can be done, and should be done, if funds are made available. Contact is being maintained with some 30 or more universities involving some 50 professors and instructors.

Special Accounts. The United Engineering Trustees, Inc., for The Engineering Foundation is custodian of seven accounts kept separate from that of the main committee:

Structural steel welding committee.
Carbon steel weldability research committee.
Weld stress committee.
Literature division.
Aircraft welding committee.
Resistance welding committee.
High alloy steels committee.

LIBRARY • • • • • •

OPERATED jointly by the AIEE and the other Founder Societies, the Engineering Socitieis Library, 29 West 39th Street, New York, N. Y., offers a wide variety of services to members all over the world. Information about these services may be obtained on inquiry to the director.

Board and Officers of Library Elected; Annual Report Issued

At the recent annual meeting of the United Engineering Trustees, Inc., W. A. Del Mar (F '20) was appointed chairman of the board of the Engineering Societies Library for 1942–43 and J. K. Finch, vice-chairman. Harrison W. Craver was reappointed director of the Library and secretary of the board.

Members of the Library board are as follows:

Terms expiring October 1943

C. E. Trout, ASCE
E. F. Church, Jr., ASME
G. L. Knight, AIEE
W. D. B. Motter, Jr., member board of trustees, UET

Terms expiring October 1944

J. K. Finch, ASCE
J. W. Laist, AIME
A. R. Mumford, ASME
W. A. Del Mar, AIEE
G. F. Felker, member-at-large

Terms expring October 1945

Edward P. Hamilton, ASCE
A. T. Hastings, AIME
John Blizard, ASME
W. I. Slichter, AIEE
S. H. Ball, member-at-large

Terms expiring October 1946

Thomas T. Read, AIME
Robert H. Barclay, member-at-large

Ex officio

G. T. Seabury, secretary, ASCE
A. B. Parsons, secretary, AIME
C. E. Davies, secretary, ASME
H. H. Henline, national secretary, AIEE
H. W. Craver, director, Library

Members of the executive committee for 1942–1943 are:

E. P. Hamilton — A. T. Hasting
E. F. Church, Jr. — W. I. Slichter

ANNUAL REPORT

The annual report of the Engineering Societies Library for the year ending September 30, 1942, has been submitted to the AIEE and other Founder Societies. Essential substance of the report follows.

The past year has been one of unusual activity, during which the work of the Library has reflected directly the burdens placed upon engineers by military needs. The inquiries have been many and varied; most of them have called for the quickest possible answers, and many, unfortunately, asked for information so recent that it was not yet in print. As in the preceding year, a notable feature was the extent to which engineers have been detached from their customary fields of work and are being compelled to orient themselves in new ones.

To such men the library has offered help to the extent of its possibilities. Book lists have been supplied and books have been lent. Much periodical literature has been cited and copied. Where inquiries fell outside the scope of the work of the library, an endeavor to suggest other courses of information was made.

An outstanding event of the year has been the use made of the library by the military authorities. There has scarcely been a day when members of Government bureaus were not engaged in research work here, and the advice of the staff has been constantly sought in sources of information snd methods of searching. Loans to Government departments have been numerous. In addition, the chief indexer has been lent to a Government bureau to assisist in devising a permanent system of indexing for military purposes.

It has been a source of great satisfaction to find how satisfactorily the collection meets the calls upon it. The large collection of foreign periodicals has proved very valuable and the catalog has answered requirements very effectively. A considerable number of periodicals appear to be available in very few other places.

During the year fluorescent lamps were installed in the reading room, with marked improvement. The lighting at night is now thoroughly satisfactory. In January 1942 work was begun upon a Japanese–English technical glossary, with the aid of a grant from the Rockefeller Foundation.

Operation of Library

Maintenance revenue		$47,967.21	
Maintenance expenditures		43,864.04	
Credit balance for year 1941–42		4,103.17	
Credit balance from previous years		7,279.62	
Credit balance September 30, 1942			$11,382.79
Service bureau revenue		$11,398.45	
Service bureau expenditures		9,749.58	
Credit balance for year 1941–42		1,648.87	
Credit balance from previous years	$10,826.01		
Less transfer to LSB reserve fund	7,500.00	3,326.01	
Credit balance September 30, 1942			4,974.88
Total net operating credit balance cumulated to September 30, 1942			$16,357.67

The want of such an aid to translators has long been felt by the director, and the lack of such a glossary has been felt acutely since the outbreak of war with Japan. Work is being pushed as rapidly as possible, but will probably require another year for completion.

During the year 23,734 persons have visited the library and 11,648 others have made use of it in other ways. Searches to the number of 103 have been made and 35 translations have been prepared. Photostats totaling 31,254 and 64 microfilms were made for 3,046 persons. Telephone requests for assistance numbered 6,097 and mail inquiries, 1,717.

It is worthy of note that the use from a distance was 32 per cent; that is, about every third person used the library from a distance. In 1941 this figure was 28 per cent and it has been growing steadily for a number of years. It is gratifying to see this increasing appreciation of the service by those at a distance, unable to visit the library. To encourage this use, the rules governing loans to members were liberalized still further. An increase of loans of 25 per cent above 1941 resulted.

While the publication of technical books in the United States has greatly increased, the great part of this output has been books for mechanics and not for engineers. With foreign book sources cut off, the number of desirable books has been decidedly less. Receipts during the year were 10,163 books, pamphlets, and so forth. Of these 5,523 proved desirable accessions and were added to the permanent collection.

As in previous years, many gifts were received from members and other friends, to whom sincere thanks are tendered. The estate of John Hays Hammond presented a large collection of periodicals and reports on mining and geology. The Library of the Massachusetts Institute of Technology presented a valuable group of bridge specifications. Many gifts have come from the National Research Council and the Society of Automotive Engineers. Sanderson and Porter, New York, N. Y., and Newell, Spencer, and Safford, New York, N. Y., donated useful engineering material. A large library was received from the estate of William T. Wallace. Doctor D. B. Steinman presented the original manuscript of "Bridges and Their Builders" by D. B. Steinman and S. R. Watson.

The library has continued to receive frequent substantial gifts from the editorial departments of the McGraw-Hill Publishing Company. It has also had hearty co-operation from many national associations of engineers and industrialists.

The number of books reviewed for the official publications of the Founder Societies was 498.

On October 1, 1941, the library contained 152,263 volumes, 7,755 maps, and 4,492 searches. Corresponding figures at the end of the fiscal year 1941–42 are 154,770 volumes, 7,845 maps, and 4,525 searches, a total of 167,140 items.

Continued efforts to dispose of duplicates by gift to other libraries or by sale have reduced the number to about 11,000 volumes and pamphlets.

About 20,000 cards were added to the periodical index, which now contains over 276,000 carefully classed references to articles on all branches of engineering.

The budget established for general operation was $46,137.00, of which amount $37,636.92 was provided by the Founder Societies on a membership basis, as follows:

American Society of Civil Engineers	$ 9,943.92
American Institute of Mining and Metallurgical Engineers	8,074.68
American Society of Mechanical Engineers	9,356.88
American Institute of Electrical Engineers	10,261.44

Expenditures from this budget were $43,864.04, of which $7,439.69 was spent for books and other equipment of permanent value. Service Bureau receipts for special service were $11,398.45. Its expenses were $9,749.58.

OTHER SOCIETIES •

Eta Kappa Nu Award Postponed

The award organization committee of Eta Kappa Nu has announced the discontinuance of its recognition award until after the war because of the impossibility of determining the details of the work of many of the most outstanding young electrical engineers of today. When the granting of the award is resumed, it is expected that it will be given for the year 1942, and possibly for intervening years. Candidates whose records are now on file will be considered eligible whenever the award is made again although at that time their age and graduation date may be beyond the usual limits.

Future Meetings of Other Societies

American Institute of Mining and Metallurgical Engineers. Annual meeting, February 14–18, 1943, New York, N. Y.

American Society of Civil Engineers. Annual meeting, January 20–22, 1943, New York, N. Y.

ASRE Officers Elected

Charles R. Logan, representative of the Superior Valve and Fittings Company of Pittsburgh, Pa., has been elected president of The American Society of Refrigerating Engineers, and was inducted into office on December 2, 1942, at the closing session of the Society's 38th annual meeting at the Hotel Commodore in New York, N. Y.

Other ASRE officers are:

Vice-president: A. B. Stickney, engineer, Armour and Company, Chicago, Ill.

Vice-president: John F. Stone, manager of the refrigeration division, Johns-Manville Corporation, New York, N. Y.

Treasurer: John G. Bergdoll, Jr., chief engineer, York Ice Machinery Corporation, York, Pa.

Directors elected by the ASRE to serve for a three-year period are:

Charles S. Leopold, consulting engineer, Philadelphia, Pa.; Lee C. Leslie, Johns-Manville Corporation, Philadelphia, Pa.; Nels Rosberg, production manager, California Consumers' Corporation, Los Angeles; Arthur B. Schellenberg, president of the Alco Valve Company, St. Louis, Mo.; J. Mack Tucker, University of Tennessee, Knoxville, Tenn.

AWS Announces New Officers

The American Welding Society has elected K. L. Hansen (F '34) consulting engineer, Harnischfeger Corporation, Milwaukee, Wis. (this issue, page 35), to serve as its president for the coming year. Other officers are as follows:

First vice-president: David Arnott, vice-president and chief surveyor, American Bureau of Ships, New York, N. Y.

Second vice-president: Isaac Harter, vice-president, The Babcock and Wilcox Company, Barberton, Ohio.

Directors-at-large: E. V. David, assistant manager, applied engineering department, Air Reduction Sales Company, New York, N. Y.; J. H. Critchett, vice-president, Union Carbide and Carbon Research Laboratories, Inc., New York, N. Y.; A. C. Weigel, vice-president, Combustion Engineering Company, New York, N. Y.; J. D. Gordon, general manager, Taylor-Winfield Corporation, Warren, Ohio.

Treasurer: O. B. J. Fraser, director of technical service, International Nickel Company, New York, N. Y.

District vice-president, New York–New England: E. R. Fish, chief engineer, boiler division, Hartford (Conn.) Steam Boiler Inspection and Insurance Company.

District vice-president, Middle Eastern: J. H. Humber-

stone, welding engineering department, Arcrods Corporation, Sparrows Point, Md.

District vice-president, Middle Western: J. D. Tebben, sales manager, Metallurgical Division, P. R. Mallory and Company, Indianapolis, Ind.

District vice-president, Southern District: K. B. Banks, assistant chief engineer, Black, Sivalls and Bryson, Oklahoma City, Okla.

District vice-president, Pacific Coast, P. D. McElfish, chief materials engineering, Los Angeles Division, Standard Oil Company of Calif., Los Angeles.

1943 Officers Elected by AIME

C. H. Mathewson, chairman of the department of metallurgy, Yale University, New Haven, Conn., recently was elected president of the American Institute of Mining and Metallurgical Engineers, New York, N. Y., for the year 1943.

Other officers elected are:

Vice-presidents: Erle V. Daveler, vice-president, Utah Copper Company, New York, N. Y.; Harvey S. Mudd, consulting engineer, Los Angeles, Calif.

Directors: H. J. Brown, consulting engineer, West Newton, Mass.; Charles H. Herty, Jr., assistant to vice-president, Bethlehem Steel Company, Bethlehem, Pa.; O. H. Johnson, vice-president, Mines and Smelter Supply Company, Denver, Colo.; Russell B. Paul, mining engineer, N. J. Zinc Company, New York, N. Y.; F. A. Wardlaw, Jr., assistant manager, International Smelting and Refining Company, Salt Lake City, Utah; Felix Edgar Wormser, secretary and treasurer, Lead Industries Association, New York, N. Y.

HONORS

Chemical Industry and Perkin Medals Awarded

The 1942 Chemical Industry Medal has been awarded to Harrison E. Howe, editor of *Industrial and Engineering Chemistry*, according to an announcement of the Society of Chemical Industry. Presentation of the medal awarded annually for valuable application of chemical research to industry, took place at a joint meeting of the American Section of the Society of Chemical Industry and the New York Section of the American Chemical Society.

The Society of Chemical Industry has announced also that the 1943 Perkin Medal, given annually for outstanding work in applied chemistry, has been awarded to Robert E. Wilson, president of the Pan American Petroleum and Transport Company, the American Oil Company, and other subsidiaries, was selected as the recipient of the medal by a committee representing the five chemical societies in the United States. Presentation will be made on January 8, 1943, at a joint meeting of the Society of Chemical Industry with the American Chemical Society, the American Institute of Chemical Engineers, the Electrochemical Society, and the Société de Chimie Industrielle.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without letter, the other lettered. Captions should be supplied for all illustrations.

A Suggestion for Saving Power—Series Versus Multiple Lighting

To the Editor:

Reference is made to a letter to the editor by L. Mackler (M '24) under the title of "A Suggestion for Saving Power," published on pages 543–4 of the October 1942 issue of *Electrical Engineering,* which revives the age-old argument of multiple street lighting systems versus series street lighting systems, with such strong apparent evidence as "this dreadful inefficiency exists only in series circuits."

It is necessary to view this letter with an open mind, since it has been demonstrated by actual practice in the public utility field during the past 25 years that there is a place for both types of street lighting systems in the economical distribution of street lighting and there are ample reasons to believe that there is an abundance of supporting data to prove that both types of street lighting systems are equally economical when properly engineered and operated. If anything the higher over-all efficiency is obtained with series street lighting circuits, when a faithful comparison is made.

In analyzing the series street lighting circuit losses indicated in this letter, it is difficult to understand how the 40–44 per cent losses would occur in the case of a series street lighting system only, assuming of course that this condition was existing during normal operation. Series street lighting normally carries 6.6 amperes and the wire size is generally number 6 or 8 American wire gauge. With this in mind it is believed that the circuit I^2R losses can be eliminated as the cause of the waste, since the loss would be very low per 1,000 feet of circuit. In this case we can proceed in the analysis to a comparison of series and multiple transformers. This immediately becomes an argument as to cost, since the efficiency of these transformers is approximately the same, roughly 96 per cent.

A series transformer is a current-regulating device, operating on the principle of magnetic induction, which when properly adjusted assures a long lamp life and uniform lighting intensity, by virtue of its current-regulating ability. A multiple transformer on the other hand is of a different design for the use of the principle of magnetic induction in that the current is permitted to increase in proportion to the load applied, within the kva rating of the transformer. In the case of the multiple transformer then, long lamp life and uniform lighting intensity are dependent upon good primary voltage regulation plus good inherent design. Good primary voltage regulation means costly plant equipment and careful maintenance; and good inherent design means regulation of at least $3^1/_2$ per cent. It is reasonable to assume then that the average regulation obtainable with multiple circuits, without an exorbitant outlay for primary regulation in excess of 5 per cent, would be approximately $7^1/_2$ per cent. This does not compare very favorably with 1 per cent current regulation obtainable with series transformers energized from an unregulated circuit.

The cost of $12.20 per kw for multiple transformers is acceptable if we neglect fixed charges, operation, and maintenance costs, but there is no reason why we must accept $96 per kw for series transformer capacity. The writer has designed a considerable number of series street lighting systems during the past 15 years and from the experience thus gained it is believed that $30 per kw for series transformer capacity would be ample when estimated on the same cost basis. Furthermore this figure would include the control equipment cost. It is pointed out that this figure is for overhead radial distribution systems. For underground circuits the figure for both multiple and series transformers would have to be increased.

In practice it has been proved that series street lighting systems are particularly advantageous in that contiguous distribution design is not seriously hampered by the street lighting load and a more economical distribution system results when the location of commercial and domestic transformers are not dependent upon the street lighting load. Series transformers have recorded extremely long service life in practice, which is due primarily to the fact that they are not affected seriously by overload and repeated short circuits. The opposite is true of all classes of multiple transformers since operating records obtainable indicate burnouts, from all causes, as high as $2^1/_2$ per cent of the transformers installed on overhead lines.

Going back to a comparison of the two types of circuits, it is pointed out that in the case of series circuits a single conductor loop of uniform wire size permits a large saving in copper over a multiple circuit in serving any unit of street lighting area. In addition a higher first cost as well as a higher maintenance and operating cost is required for multiple load relays when utilizing the distribution transformers on a multiple street lighting system.

It is believed that it would be well to look for reasons other than the electrical characteristics of the two types of circuits being compared in Mr. Mackler's letter, especially since such a wide margin has been recorded in losses and no convincing sup-

porting data have been advanced. Too, under wartime dim-outs and black-outs of street lighting it would be questionable saving indeed to revamp all series street lighting circuits at this time, even if it were economically feasible. But as for putting series circuits at the top of the list in the rationing of power, it is suggested that this part of power ration be given more engineering study before action is advised.

WILLIAM A. CROW

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An A-C Bridge

To the Editor:

At the University of Kansas last summer I conceived the a-c bridge shown in Figure 1. The principle involved is very simple. If $R=\sqrt{\frac{L}{C}}$, arm 1–2 is resonant at all frequencies and has a purely resistive impedance equal to $\sqrt{\frac{L}{C}}$. The bridge is therefore balanced at all frequencies, including zero. The balance equation,

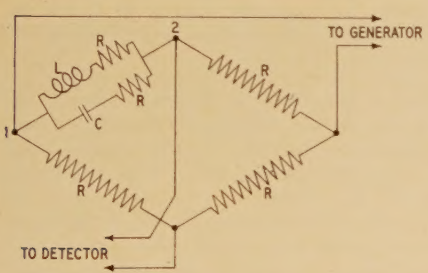

Figure 1

$L=CR^2$, can be used to compare inductances with capacitances.

Very little is known of the sensitivity of the circuit. Some rough measurements made at audio frequencies have indicated that the balance equation is approximately correct, and that harmonics in the generator are partially cancelled when the fundamental is balanced out.

BEN PETREE (Enrolled Student)

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Terminal Corrections for Temperature Tests on Short Conductors

To the Editor:

In an interesting letter by Frederick Bauer and Jerome J. Taylor, entitled "Terminal Corrections for Temperature Tests on Short Samples," published in the November issue of *Electrical Engineering*, pages 584–5, methods are given for computing the cooling effect produced by terminals upon the temperature of conductors connected to them.

The method given is entirely correct for conductors which are of infinite length or for conductors sufficiently long, as is the case in the example given, that the cooling effect of the terminal has a negligible effect upon the temperature at or near the center. It is, however, not correct for thermally short conductors, as will be shown.

In my paper, "The Compensated Thermocouple Ammeter," published in AIEE *Transactions*, volume 55, 1936, January section, pages 22–33, the problems given in the letter referred to were treated in general. The paper on thermocouple ammeters might more appropriately have been entitled, "The Temperatures Along a Conductor to Which Heat Is Added or Removed Uniformly Throughout Its Length, Connected to Terminals, and Mounted in a Cooling (or Heating) Medium."

In the paper on thermocouple ammeters equation 5

$$\theta=\theta_0-\left[\frac{(\theta_0-T_1)\sinh(L-x)n+(\theta_0-T_2)\sinh xn}{\sinh Ln}\right]$$

is the general equation for the temperature θ at any point at a distance x along a conductor of any length L, from a terminal at temperature T_1 to a terminal at temperature T_2 at a distance $x=L$. All temperatures are relative to that of the surrounding medium.

In this equation

$$n=\sqrt{\frac{c}{ak}}$$

is the thermal length of the conductor per unit length in hyperbolic radians in which c is the heat lost to the surrounding air per unit length of conductor per degree;

a is the cross-sectional area of the conductor and k its thermal conductivity.

In this equation the value of n, c, and $1/ak$ correspond respectively to α, h, and r in the equation of Messrs. Bauer and Taylor for α.

In connection with the latter equation, attention is called to a typographical error which might cause confusion, namely, r should be the thermal resistance and not resistivity.

In the general equation θ_0 is the temperature, relative to the surrounding air, the conductor would have if no heat were lost to the terminals, and it is the temperature above ambient at the center of a conductor so long, thermally, that this temperature is not affected by the terminals. The temperature θ_0 added to the ambient temperature corresponds to the temperature at the center of the long conductor referred to in the letter of Messrs. Bauer and Taylor.

If in this equation L is made infinite, the equation reduces to,

$$\theta=\theta_0-[(\theta_0-T_1)e^{-nx}]$$

which is the same as that given in the letter of Messrs. Bauer and Taylor.

This equation may be modified to bring out its physical meaning more clearly by putting the difference in temperature between any point x and the terminal, in terms of the difference in temperature between the center and the terminal, by subtracting from each side the temperature T of the terminals assumed equal, we then have $(\theta-T)=(\theta_0-T)(1-e^{-nx})$. If we employ this equation, which is correct for thermally long conductors only, for thermally short conductors and assume that θ_0 for the center of a long conductor can be used equally well for short conductors having at emperature of θ_c at the center, then the equation, although incorrect, would be $(\theta-T)=(\theta_c-T)(1-e^{-nx})$.

To show that this is incorrect for short conductors, assume that the length is 2 feet instead of 30 feet as given in the example of Messrs. Bauer and Taylor, then, using their constants,

$$(\theta-T)=(\theta_c-T)(1-e^{-0.135\times 12})$$

or

$$(\theta-T)=(\theta_c-T)(1-0.2)=(\theta_c-T)\times 0.8$$

that is, the computed temperature of the center above that of the terminal is 20 per cent less than the measured value, and other parts of the conductor will have corresponding errors.

For the 30-foot conductor used in the example the corresponding ratio would be,

$$(1-e^{-0.135\times 180})=0.9999993$$

which shows the great difference between computed values for long and short conductors.

The correct equation in general for the temperature at any part of a conductor of any length, in terms of the measured value at the center when the two terminals have the same temperature T, is obtained from the general equation given previously by first determining the temperature θ_c at the center by making $x=L/2$, and then eliminating θ_0, from which we obtain,

$$(\theta-T)=\frac{(\theta_c-T)}{\left(1-\dfrac{1}{\cosh \dfrac{Ln}{2}}\right)}\times\left[1-\frac{\sinh(L-x)n+\sinh xn}{\sinh Ln}\right]$$

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Railway Electrification

To the Editor:

A recent issue of the *Railway Gazette* of London indicates that as of March 1, 1942, the last of the electrification between Jörn and Boden in Sweden gives the Swedish State Railways the distinction of owning the longest continuous railway electrification in the world, from Riksgränsen to Tälleborg. This distance is 1,349 miles and if the Norwegian section between Riksgränsen and Narvik be added, the total electrification is 1,376 miles.

It is pointed out that the German electrification from Saalfeld through Munich and the Brenner Pass, and the Italian electrification from Brennero through Verano to Reggio constitutes a continuous electrification of 1,268 miles, 366 miles of which is in Germany and 902 miles in Italy. There is thus continuous electric operation from the Arctic Circle to the Mediterranean Sea (with the exception of the Baltic Sea crossing the section between the Baltic and Saalfeld) totalling 2,644 miles.

Four systems of power distribution are used, the Swedish and German railroads being single phase at 16,000 and 15,000 volts respectively, and the Italian railroads being three phase at 3,700 volts and direct current at 3,000 volts.

It is interesting to note the extent of electric operation in view of the complications in construction and operation incident to the war.

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NEW BOOKS • • •

The following new books are among those recently received from the publishers. Books designated ESL are available at the Engineering Societies Library; these and thousands of other technical books may be borrowed from the library by mail by AIEE members. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books. All inquiries relating to the purchase of any book reviewed in these columns should be addressed to the publisher of the book in question.

X-Ray Crystallography. By M. J. Buerger. John Wiley and Sons, New York; Chapman and Hall, London, 1942. 531 pages, illustrations, etc., $9^1/_2$ by 6 inches, cloth, $6.50. (ESL).

Intended to provide a connected account of the theory and practice of structural investigations by means of the X-ray. Methods that utilize a single crystal and monochromatic X-rays and the theory necessary for the intelligent use of these methods are discussed. Much of the material appears in print for the first time.

Plastics. By J. H. DuBois. American Technical Society, Chicago, Ill., 1942. 295 pages, illustrations, etc., $8^1/_2$ by $5^1/_2$ inches, cloth, $3. (ESL).

Written for users of plastics who wish practical information concerning these materials, this book outlines the history and origin of the various types of plastics and the sources of their raw materials. Their physical, chemical, and electrical properties are discussed, as well as their advantages and defects. Due attention is paid to their fabrication, and information on design is presented.

Molecular Films, the Cyclotron and the New Biology. By H. S. Taylor, E. O. Lawrence, I. Langmuir. Rutgers University Press, New Brunswick, N. J., 1942. 95 pages, illustrations, etc., $9^1/_2$ by 6 inches, cloth, $1.25. (ESL).

These essays by three distinguished scientists present historical and contemporary concepts that will help to solve some of the most difficult problems in biology. Dr. Taylor provides the historical background with a review of scientific thought during the last two centuries. Dr. Lawrence describes the cyclotron and calls attention to its promise as a means for studying biological problems. Dr. Langmuir presents the surface-film method of investigation, describes some results obtained and suggests further uses.

American Electricians' Handbook. By T. Croft, revised by C. C. Carr. 5th edition. McGraw-Hill Book Company, New York, N. Y., and London, England, 1942. 1,634 pages, illustrations, etc., 8 by 5 inches, $5. (ESL).

The new edition of this well-known reference book has been thoroughly revised and considerably expanded, new sections on the properties and splicing of conductors and on general electric equipment and batteries have been added, and others have been rearranged. The book aims to meet the needs of those having little technical training by providing accurate information, based on correct engineering principles, in simple language.

New Technical and Commercial Dictionary. Part I, Spanish–English; Part II, English–Spanish; Part III, Conversion Tables of Weights, Measures, and Monetary Units. Compiled by A. P. Guerrero. Editorial Técnica Unida and Chemical Publishing Company, Brooklyn, N. Y. 1942. 600 pages, tables, $9^1/_2$ by 6 inches, fabrikoid, $10. (ESL).

This dictionary contains more than 50,000 words used in electrical, mechanical, chemical and marine engineering, radio, mining, textile, and other industries. It includes modern words referring to mechanized and motorized warfare, aviation, meteorology, and other technical fields.

Poisson's Exponential Binomial Limits. Table I—Individual Terms; Table II—Cumulated Terms. By E. C. Molina. D. Van Nostrand Company, New York, N. Y., 1942. 47 pages, tables, 11 by 8 inches, paper, $2.75. (ESL).

These tables give the numerical limiting values of the individual and cumulative terms for values of the parameter from 0.001 to 100. Originally prepared by the Bell Telephone System for use in solving switching and traffic problems, they are also very useful in handling inspection data and solving problems of sampling.

Powder Metallurgy. Edited by J. Wulff. American Society for Metals, Cleveland, Ohio, 1942. 622 pages, illustrations, etc., $9^1/_2$ by 6 inches, $7.50. (ESL).

Contains papers presented at conferences held in 1940 and 1941 at the Massachusetts Institute of Technology, Cambridge. Various problems connected with the preparation and use of metal powder are discussed by specialists, and a large amount of information is presented in convenient form. Most chapters have bibliographies.

Procedure Handbook of Arc Welding Design and Practice. 7th edition. Lincoln Electric Company, Cleveland, Ohio, 1942. 1,267 pages, illustrations, etc., 9 by 6 inches, fabrikoid, $1.50 in U.S.A.; $2 elsewhere. (ESL).

This reference book attempts to present a comprehensive, authoritative description of the arc-welding process. Methods and equipment, welding technique, procedures, speeds, costs, test methods, design of welded machines and structures, and typical applications of welding are considered. The new edition has been revised and enlarged.

Tables of Probability Functions. Volume 2. Prepared by the Federal Works Agency, Work Projects Administration for the City of New York, N. Y., conducted under the sponsorship of and for sale by the National Bureau of Standards, Washington, D. C., 1942. 344 pages, tables, 11 by 8 inches, cloth, $2. (ESL).

The two functions tabulated here are frequently called the ordinate and area respectively of the normal frequency curve, and are of fundamental importance in statistics, especially in testing the significance of a deviation in a normally distributed variate and in fitting normal distributions to observations. The tables extend to 15 decimal places, at intervals of 0.0001 for x ranging from 0 to 1, and at intervals of 0.001 for x ranging from 1 to 7.8.

Cable Car Days in San Francisco. By E. M. Kahn. Stanford University Press, Stanford University, Calif., 1941. 124 pages, illustrations, etc., 10 by 7 inches, cloth, $3. (ESL).

A pleasant, informal account of the cable street railways of San Francisco, from their beginnings down to the present time. Photographs and drawings add to the attractiveness of the text.

PAMPHLETS • • •

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

Tin—Base Bearing Metals (publication number III). By W. T. Pell-Walpole, J. C. Prytherch, Bruce Chalmers. Battelle Memorial Institute, Columbus, Ohio; Tin Research Institute, Fraser Road, Greenford, Middlesex, England, 1942. 38 pages, no charge for single copies.

The Specific Heats of Certain Gases Over Wide Ranges of Pressures and Temperatures. By Frank O. Ellenwood, Nicholas Kulik, Norman Gay, Cornell University Engineering Experiment Station, Ithaca, N. Y., 1942. 22 pages, no charge for single copies (additional copies 50 cents).

The Future of Transportation. National Resources Planning Board, Washington, D. C., 1942. 43 pages.